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Prescription Opioid Resiliency and Vulnerability: A Mixed-Methods Comparative Case Study

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Abstract
Despite declines in prescription opioid overdoses, rural areas continue to have higher prescription opioid overdose rates than urban areas. We aim to understand high overdose places were resilient to the prescription opioid overdose crisis (better than predicted), while others were vulnerable (worse than predicted). First, we predicted prescription opioid overdose mortality in 2016–18 for $N=2,013$ non-metropolitan counties using multivariable regression accounting. Second, we constructed a resiliency-vulnerability typology using observed, predicted, and residual values from the regression. Third, we selected a high-overdose resilient and vulnerable community for case study analysis using interviews, focus groups, and observations. High-overdose resilient and vulnerable places had disability-dispensing-overdose pathways, legacies of mining, and polysubstance drug abuse. Resilient places were larger population micropolitans with extensive health and social services, norms of redemption and acceptance of addiction, and community-wide mobilization of public and non-profit resources. Vulnerable places were smaller, more remote, lacked services, and stigmatized addiction.

Keywords Prescription opioid overdose · Rural · Community resiliency · Mixed methods

Introduction

In the past two decades, fatal opioid overdoses have increased significantly and remain a major public health crisis in the United States (Jalal et al., 2018). Two-thirds of all overdose deaths involve opioids (CDC, 2019). Across the nation, overdose deaths from prescription opioids have fallen from their peak in 2011 (see Fig. 1). This

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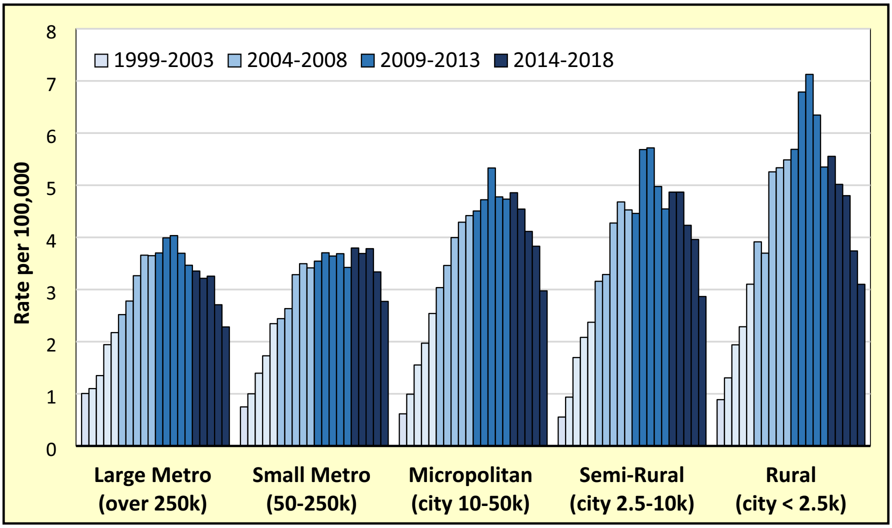

Fig. 1 Prescription Opioid Overdose Mortality Rates (Age-Adjusted) for $N = 3,079$ Counties in the Conterminous United States

decline is partly attributed to stronger regulations and tighter prescribing (Dowell et al., 2016; Lee et al., 2021). However, the decline was also driven by the increased availability of cheaper illicit opioids as an alternative (Cicero & Ellis, 2015). For many years, pills were the predominant avenue to opioid addiction and dependence (Cicero et al., 2017, 2020). Despite a national shift from pharmaceuticals to illicit opioids (heroin and synthetic analogs), deaths from prescription analgesics remain a significant contributor to drug-related mortality in rural America; and there are some concerns that prescription opioid use disorders may rebound given increases in physician opioid prescribing to COVID-19 long-hauler patients (Silva & Kelly, 2020).

Extant research using secondary data provides understanding of the economic and demographic drivers of the opioid overdose crisis, but to our knowledge there is no research examining why communities that appear similar across multiple economic and demographic measures have disparate outcomes in opioid deaths (Ciccarone, 2018;Dasgupta et al., 2018; Monnat, 2020; Peters et al., 2020; Ziyad & Xie, 2021). Socioeconomic and drug risk conditions (such as disability, dispensing, and past drug overdoses) explain 40 to 50 percent of county-level variation in opioid-related overdose mortality (Peters et al., 2020). However, what accounts for the sizable remaining variation is unclear. Our purpose is to understand why some rural communities appear to have been resilient or vulnerable to prescription opioid mortality, since much can be learned from places that regression models do not accurately predict. For example, communities doing better than predicted by models may provide insights on local strategies or social norms that reduce drug use disorders and subsequent overdose. In what follows, we predict prescription opioid overdose deaths using regression models on county-level factors. Second, we identify and describe resilient and vulnerable rural counties based on differences in observed versus predicted prescription opioid mortality. Last, we present findings from a comparative case study of two socioeconomically similar communities where prescription opioids comprise much of the overdose problem. Our analysis contributes to rural health research and practice by identifying local actions that may ameliorate or exacerbate existing drug problems, but are not yet documented in the literature. It also demonstrates the merits of using a mixed-method strategy for identifying and examining case study communities in rural health research.

Literature Review

The contemporary U.S. drug overdose crisis has unfolded over four waves. The first wave (late-1990s to late-2000s) was characterized by a surge in prescription opioid overdoses, which was followed by a second wave of heroin overdoses. The fentanyl and synthetic opioid surge constituted the third wave in the mid-2010s. The current wave is dominated by poly-substance overdoses, including a mixture of opioids and psychostimulants like cocaine and methamphetamine (Ciccarone, 2018). Despite recent declines in overdoses involving prescription opioids, prescription opioid overdose rates remain higher in rural than in urban areas (Peters et al., 2020).

A body of empirical work has identified the place-level compositional and contextual factors that explain geographic differences in contemporary drug overdose rates. These predictors include higher rates of opioid prescribing, poverty, unemployment, disability (Alterkruse et al., 2020; Betz and Jones, 2018; Hollingsworth et al., 2017a, 2017b; Monnat, 2018; Monnat & Rigg, 2016; Monnat et al., 2019; Paulozzi & Annest, 2007; Ruhm, 2019). Counties dependent on mining and service sector employment have higher rates of opioid overdose (Hawkins et al., 2019; Monnat, 2019). The rise in fatal drug overdose rates was attributable largely to worsening labor market opportunities for less educated individuals and reduced attachment to social capital promoting institutions (Case & Deaton, 2020).

In particular, high rates of prescription opioid overdoses tend to be clustered in more economically-disadvantaged rural counties (Peters et al., 2020). Rural communities are both older and have larger shares of workers in injury-prone industries (Case & Deaton, 2020; Dasgupta et al., 2018; Peters et al., 2020). Treatment for work-related pain with analgesics may have provided the initial impetus for the geographic concentration of high-prescribing physicians in certain rural communities (Frasquilho et al., 2016; Quinones, 2015). Higher rates of "recreational" drug use may also play a part, as the rate of non-medical users to medical users is higher in rural areas (Cicero et al., 2007; Dew et al., 2007; Keyes et al., 2014; McCauley et al., 2010). Disparities in drug treatment also contributes to geographic disparities in overdose rates, as is the case for other health issues (Abello et al., 2019; Afshar et al., 2019; Hammond, et al., 2020; Lam et al., 2018; Nicoli et al., 2019). Ultimately, supply and demand factors combined to create the rural opioid crisis (Monnat, 2020; SAMHSA, 2016; Jenkins, 2021).

Data and Methods

Prescription opioid overdose mortality is defined as fatal drug overdoses involving only natural or semi-synthetic opioids, including methadone.[1] This definition excludes overdoses from illicit opioids (e.g. heroin and fentanyl) and mixtures containing two or more opioid substances (e.g. counterfeit hydrocodone using fentanyl). Our rationale is that research on the spatial distribution of opioids shows that there are distinct opioid problems, especially at the time of this research, with different spatial distributions and unique causes (Peters et al., 2020). Fentanyl deaths were rare in our case study sites as well at the time of this research and when they occurred it generally was from black market not prescribed fentanyl, as death from diverted, legally produced fentanyl are relatively rare. Units of analysis are $N=2{,}103$ non-metropolitan counties in the 48 conterminous United States based on 2000 Census geographies.[2] Data are from restricted cause-of-death mortality files from the National Vital Statistics System.[2] Opioid mortality rates per 100,000 population are age-adjusted (based on 2010 Census) by residence of the decedent; and are pooled over a three-year period between 1999 and 2018 to reduce noise that may occur from annual fluctuations in small population counties (Rothman et al., 2008).

County-level demographic and socioeconomic data were primarily obtained from the Census Bureau's American Community Survey (2008–12 and 2014–18 ACS) and previous decennial censuses, unless otherwise noted. In addition to self-explanatory demographic variables, locational variables include the USDA's natural amenities subscales for topographic variation and water area (z-scores); and density of interstate road lengths per square mile calculated using ESRI files to model transportation access and drug trafficking corridors (DEA, 2020). Drug risk factors were selected based on extant research (Monnat, 2019; Rigg et al., 2018). Spatially lagged prescription opioid overdose mortality captures spillover across neighboring counties using queen contiguity. Fatal non-opioid drug overdoses per 100,000 from the CDC measures general drug misuse in the county. Prescription opioid dispensing rates per 100 people is used to measure supply, taken from QuintilesIMS Transactional Data Warehouse with imputation of missing cells. Work disabled individuals as a percent of the population is from the Social Security Administration's OASDI program. Health and social services provision is measured by place-of-work employment per 10,000 in retail pharmacies, offices of physicians, mental health and substance abuse centers, hospitals, and family social service providers. Data are from the Upjohn Institute's WholeData, which estimates employment from Census Bureau's County Business Patterns (CBP). State drug policy variables are from the Prescription Drug Abuse Policy System website (PDAPS, 2021).

[1] International Classification of Diseases (ICD-10) codes defining prescription opioid overdose mortality include: drug poisonings (X40-44, X60-64, X85, or Y10-14) plus the presence of prescription opioids including methadone (T40.2 or T40.3).

[2] Census geographies from 2000 were modified to prevent breaks in the spatial time-series. Independent cities in Virginia with populations under 65,000 were merged back into their respective counties. All data used in this study conform to these spatial units. We use 2003 Core-Based Statistical Area (CBSA) definitions for metropolitan and non-metropolitan.

Social and economic conditions include the person poverty rate, the 80:20 income gap to measure inequality (quotient of income shares owned by the top and bottom 20th percentiles), and the percentage of vacant housing units. Property crime rates per 100,000 people come from the FBI's Uniform Crime Reports as an indicator of community disorder contributing to drug mortality. UCR data are voluntarily reported, resulting in missing cells that were filled using: county crime counts from state agencies, imputation of missing cells if values were consistent, and mean substitute of state averages by urban influence code. Social capital is measured using employment per 10,000 in religious organizations, community and civic groups, work-related organizations, and local media (newspapers, radio, and television) – all taken from WholeData/CBP. Employment by industry sector is used to identify injury-prone jobs that may contribute to drug use. Employment by place-of-residence is used for consistency with CDC mortality data by residence. We include change over two decades to capture long-term consequences of economic restructuring on overdose mortality.

The first part of our analysis strategy is to predict prescription opioid mortality using covariates identified in the literature. A negative binomial Poisson regression is used to predict mortality rates in 2016–18 using lagged covariates from 2010 and change between 2000 and 2010. The model, presented in Appendix Table 2, accounts for 40.1% of the variation in mortality rates. We estimated models for other types of opioid overdoses (such as heroin alone, synthetic opioids alone, and opioid mixtures). However, we focus on prescription opioids because overdose rates are higher in non-metropolitan areas; and prescription markets function differently from illicit ones, the latter being similar to other illicit drugs like cocaine and methamphetamine (DEA 2021). Second, we constructed a prescription opioid resiliency-vulnerability typology using standardized observed mortality rates, model-predicted values, and model residuals. Extreme values are defined as the top and bottom 20th percentiles, equal to a *z*-score of $\pm$0.84. Average values are defined as a *z*-score of 0.15 or lower. *True resilient* counties are those that did much better than predicted by the model, where mortality was predicted to be high but observed to be average ($e_z < -0.84$, $\hat{y}_z > 0.84$, $y_z < 0.15$). *High overdose resilient* counties also did much better than predicted, but observed prescription opioid mortality was still high ($e_z < -0.84$, $\hat{y}_z > 0.84$, $y_z > 0.84$). By contrast, *true vulnerable* counties did worse than expected, where mortality was predicted to be average but was in fact observed to be high ($e_z > 0.84$, $\hat{y}_z < 0.15$, $y_z > 0.84$). *High overdose vulnerable* places also did worse than predicted, but observed mortality was much higher than predicted by the model ($e_z > 0.84$, $\hat{y}_z > 0.84$, $y_z > 0.84$). We arrived at these categorical titles on completion of the research; the designations are intended only as reference to patterns of residuals. Readers might as easily number the categories. Figure 2 depicts the magnitude of residual, observed, and predicted values. Indicators used in the statistical models are primarily obtained from the U.S. Census Bureau's American Community Survey, previous decennial Census periods, and other secondary sources described in the appendix.

We then compared socioeconomic conditions of counties in the resiliency-vulnerability typology using a multivariable general linear model (MANOVA) to test for unconditional mean differences using the Games-Howell test (Johnson & Wichern, 2007). We use the findings from these models to identify counties for an intrinsic case study analysis. We selected one *high overdose resilient* and one *high overdose vulnerable* community to understand how high-risk places might respond differently

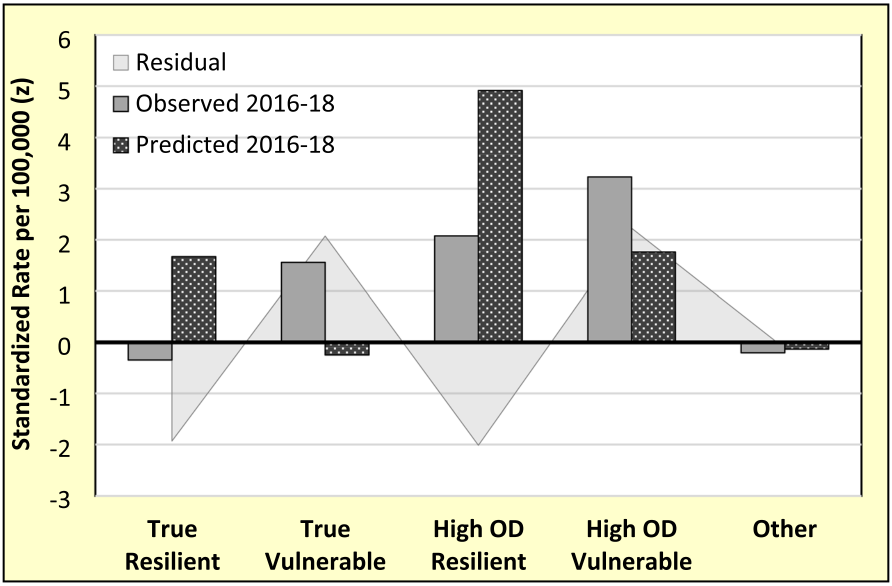

Fig. 2 Predicted and Observed Prescription Opioid Overdose Mortality Rates (Age-Adjusted, Standardized) from the Negative Binomial Regression Model for $N = 2{,}013$ Non-Metropolitan Counties

to the opioid crisis. The two non-metropolitan counties from the same state to avoid biases associated with differences in state-level policies, politics, and culture.

Our interpretative or qualitative methodological approach uses an intrinsic cross-case study analysis, where we identify and explore unique or outlier cases that defies conventional explanations (Creswell & Poth, 2018; Yin, 2013). Case study sites were empirically selected using the following process. First, counties in the high overdose resilient and high overdose vulnerable groups were sorted by their maximal scores. For example, top resilient counties had the largest negative residuals and highest observed overdose mortality, while top vulnerable has largest positive residuals and highest mortality. Second, we searched for pairs of top resilient and vulnerable counties in the same state. Third, within states we selected pairs that were in close geographic proximity. This process ensured, as much as possible, that the case study sites were bounded by the same time and space. We employed an embedded data collection approach, focusing on information specifically related to drug addiction and mortality.

We collected data from secondary sources, key informant interviews, focus groups, and observational assessments. From this corpus of data we identified several initial assertions, or major themes, that were confirmed with follow-up virtual interviews with key informants. We completed interviews with 32 key informants, held six focus groups, conducted observational assessment of the community's physical environment, and had many informal conversations with community members. Key informants included teachers and school principals, emergency workers and medical personnel, substance use treatment personnel in medical and faith-based programs, prosecutors and drug court personnel, law enforcement and drug task force officers, local elected officials, and concerned citizens. Interviews took place in the fall and winter of 2019–2020, supplemented with video interviews during COVID-19. **This research was funded by the National Institute of Justice,** Award #: NIJ 2018-AR-BX-0004, and USDA, AFRI, Award #: 2018–68,006-27,640, and is governed by the Institutional Review Board at Iowa State University #18–498-01. Sponsors had no role in collection, analysis and interpretation of data, report writing or decision to submit the article for publication. As the paper's focus was on community response, we did not target reformed or active drug users explicitly or ask participants to voice personal or family stories related to opioid use. The literature on drug users in impoverished communities is abundant. We admit to the bias of listening to public officials and concerned residents about their small communities; nevertheless, the crux of this paper is that their perceptions may not be entirely objective, are certainly shaped by local conditions, and we also contend that their actions and perceptions matter.

Results

Before proceeding to the findings from the case studies, we present a national overview of counties that were either resilient or vulnerable to high rates of prescription opioid overdose. The spatial distribution of counties in the resiliency-vulnerability typology is presented in Fig. 3; and mean differences across socioeconomic and health status variables are shown in Table 1.

Prescription Opioid Resiliency and Vulnerability

True resilient places are those that should have had a prescription opioid overdose problem but did not, where predicted mortality of 8.98 deaths per 100,000 was much lower than the actual rate 1.72 (below national average of 3.24 per 100,000). These 37 rural counties are distributed mostly in Utah, Oklahoma, Tennessee, and Washington. Although true resilient places had low prescription opioid mortality, this does not signal the absence of a drug problem, as deaths from methamphetamine and illicit opioids were high. Although it is unclear what may be driving prescription resiliency, we found these places to have larger shares of Native American and mixed race people, but few federal reservations. They also have fast population growth due to in-migration of whites. We speculate the long-term Native population and newly-arrived whites raised risk conditions, but people who use drugs in these communities may have an aversion to prescriptions or may have preferences for other substances. For Natives, few federal reservations also means an absence of Indian Health Service clinics that may limit prescription opioid supply.

By contrast, the 109 *true vulnerable* counties should not have a prescription opioid problem when in fact they do have one. Overdose mortality was predicted at a low but the actual rate was high (2.51 versus 10.07 per 100,000). These counties tended to be sparsely populated, rural and remote, and more socioeconomically advantaged than resilient and high overdose vulnerable places. We identified two potential factors that may explain higher-than-anticipated rates of prescription opioid overdoses in these communities. First, there is a large agricultural sector, high rates of in-migration, and larger shares of

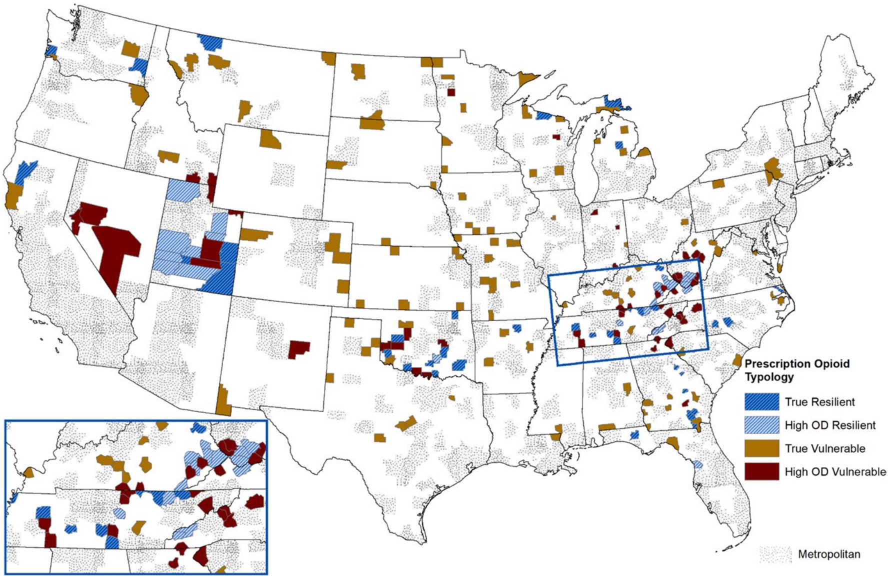

Fig. 3 Map of the Prescription Opioid Resiliency-Vulnerability Typology

minorities. Agriculture is on an industrial scale, typically large cattle feedlots, dairies, hog and poultry production, and to a lesser extent fruits and vegetables. This work is prone to work injuries that may have led to opioid use disorders and overdose. Second, true vulnerable counties are located in states with the weakest prescription opioid regulations.

We next turn our attention to resiliency and vulnerability in high risk and high overdose communities. *High overdose (OD) resilient* counties have high prescription overdose mortality (12.35 per 100,000), but rates are much lower than predicted by models given their high risk conditions (21.72 per 100,000). Unlike true resilient places, these communities have a general drug problem with high mortality rates involving methamphetamine and illicit opioids. These 24 counties are located in states at the epicenter of the opioid epidemic in Kentucky and West Virginia, but also in Utah. High OD resilient communities epitomize the disability-dispensing-overdose pathway often cited in public health research (Monnat et al., 2019). These communities are mostly white with many jobs in mining, high work disability, high prescription opioid dispensing, more pharmacies and physician offices, and more social disorganization (evidenced by high rates unemployment, property crime, and low social capital). What makes these disadvantaged places resilient in the face of these risk factors? The data show that resilient places have larger and younger populations and well-developed social services. In addition, state governments in this group were some of the first to enact strict prescription drug monitoring laws, limits on opioid prescribing, and regulation of pain clinics. Such policies may have helped reduce prescription opioid overdoses, but overdoses involving illicit opioids remain high in these counties.

Lastly, *high overdose (OD) vulnerable* communities have a major prescription opioid problem that has only worsened over time. Mortality was predicted at 9.28 deaths per

Table 1 County-Level Differences between Prescription Opioid Resiliency-Vulnerability Typology Groups

	(a) True Resilient $N=37$		(b) True Vulnerable $N=109$		(c) High OD Resilient $N=24$		(d) High OD Vulnerable $N=49$	
Demographics and Location 2018								
Population (1 k)	21.81	bc	15.15	ac	33.28	abd	20.78	c
Percent Change from 2000	6.94	b	-0.45	a	3.34		2.91	
Age 25 and younger (%)	30.42		29.43	c	32.28	bd	30.24	c
Age 65 and older (%)	19.63	c	20.93	c	18.00	abd	19.89	c
Hispanic any race (%)	4.91		7.45	c	4.61	B	6.49	
African American (%)	7.78	cd	7.27	cd	1.56	ab	2.20	ab
Other or multiple races (%)	10.15	bc	5.19	a	5.26	A	6.15	
New residents within last year (%)	6.97	cd	6.71	cd	5.56	ab	5.66	ab
Micropolitan (%)	24.32		16.51	c	37.50	bd	20.41	c
Interstate density (mi^2*100)	1.04		0.48	d	0.69	D	1.30	bc
Topographic variation (z)	0.14	cd	0.02	cd	1.13	abd	0.69	abc
Social Disorganization 2018								
Poverty (%)	19.50	b	17.21	ac	20.13	B	19.01	
Property crimes 2014–16 (per 100 k)	353.18	c	277.20	c	579.81	abd	327.21	c
Religious org. jobs (per 10 k)	34.46	c	41.51	cd	20.86	abd	30.62	bc
Community & social org. jobs (per 10 k)	7.52	c	10.05	cd	4.32	ab	5.02	b
Charitable contributions ($ per capital)	182.76		180.86		226.91	D	172.27	c
Drug Risk 2018								
Rx opioid dispensing 2016–18 (per 100)	80.35	bc	59.49	acd	126.20	abd	87.43	bc
Work disabled population (%)	4.22	bcd	3.67	acd	5.54	ab	5.06	ab
Retail pharmacy jobs (per 10 k)	20.03	c	18.53	c	29.43	abd	19.93	c
Physician office jobs (per 10 k)	34.65	c	27.12	c	65.47	abd	26.52	c
Mental health/substance abuse jobs (per 10 k)	4.23	cd	7.20	c	16.76	abd	10.38	ac
Hospital jobs (per 10 k)	89.57	bc	132.97	ac	177.44	abd	126.75	c
Family social services jobs (per 10 k)	24.98	c	31.14	c	53.28	abd	30.05	c
Drug Mortality (any cause) 2016–18								
Rx opioid mortality (per 100 k)	1.97	bcd	10.44	acd	13.14	abd	18.24	abc
Heroin mortality (per 100 k)	0.99		1.12		1.33		1.24	
Synthetic opioid mortality (per 100 k)	4.36	c	3.61	cd	6.51	ab	5.91	b
Multi-opioid mixtures mortality (per 100 k)	2.18	cd	2.11	cd	5.72	ab	4.69	ab
Methamphetamine mortality (per 100 k)	6.34	cd	5.80	cd	9.47	abd	12.74	abc
Rx sedatives mortality (per 100 k)	0.72	cd	1.11	cd	3.08	ab	4.03	ab
Rx antidepressants mortality (per 100 k)	1.76	cd	2.48	cd	4.42	ab	5.15	ab
Employment 2018								
Labor force participation (%)	38.88	bc	42.18	acd	36.76	ab	37.96	b
Agriculture, forestry & fishing (%)	3.83	b	7.76	acd	3.14	B	3.76	b
Change from 1990	-2.94	bc	-5.77	acd	-1.52	abd	-3.13	bc

Table 1 (continued)

	(a) True Resilient $N=37$		(b) True Vulnerable $N=109$		(c) High OD Resilient $N=24$		(d) High OD Vulnerable $N=49$	
Mining (%)	1.70	cd	1.77	cd	4.76	ab	3.75	ab
Change from 1990	-0.41	bcd	0.30	acd	-4.37	abd	-2.06	abc
Manufacturing (%)	11.75	c	11.66	c	7.89	abd	12.10	c
Change from 1990	-9.12	bc	-4.97	ad	-3.96	ad	-9.23	bc
Construction (%)	8.01	c	7.95	c	6.73	ab	7.21	
Change from 1990	0.70	c	1.16	cd	-0.33	ab	-0.14	b
Transportation & warehousing (%)	4.03		4.41		4.48		4.20	
Change from 1990	0.17		0.47	c	-0.12	B	0.14	
Retail trade & leisure services (%)	25.68	b	23.57	acd	25.88	B	25.82	b
Change from 1990	4.15	c	3.35	cd	1.58	abd	5.75	bc
State Policy								
PDMP in operation (years since 1990)	15.19	c	12.42	cd	18.88	ab	17.57	b
PDMP access strength (1–5)	4.00	b	3.39	acd	4.04	B	4.16	b
PDMP mandatory reporting strength (1–4)	1.92	cd	1.72	cd	2.42	ab	2.45	ab
Physician Rx opioid dose limits (0–2)	0.46	c	0.40	c	1.25	abd	0.47	c
Regulation of pain clinics (0–2)	0.97	c	0.72	cd	1.33	abd	1.04	bc
Drug homicide law (0–2)	1.35	bc	0.71	ad	0.75	ad	1.22	bc

Games-Howell mean difference test using Bootstrap standard errors at $P<.05$; two-tailed

a different from true resilient; *b* different from true vulnerable; *c* different from high OD resilient; *d* different from high OD vulnerable

100,000, but actual rate was nearly double at 17.41 per 100,000. In fact, these places have high mortality from multiple drugs, including methamphetamine, prescription sedatives and anti-depressants, and illicit opioids. These 49 counties are predominantly located in Appalachia, Oklahoma, and the Mountain West. Vulnerable counties share many of the same features as high OD resilient places, with some exceptions. High overdose vulnerable places are more sparsely populated and primarily located in more rural areas with very small towns, but are also well-connected to the interstate system. Mining employment is sizable but has shrunk over the past three decades, though to a lesser degree than in resilient places. What sets high OD vulnerable communities apart is the steep decline in manufacturing jobs since the 1990s. This suggests that high OD vulnerability tends to occur in former rural factory towns that lack critical social services, whereas high OD resilient places tend to occur in larger micropolitan cities with adequate service provision. In the current case, the vulnerable location lacked basic hospital and accessible emergency response as well as law enforcement capacity to be proactive in combating drugs.

Case Study of High Overdose Resilient and Vulnerable Rural Communities

Both site visit counties were comprised only of small towns. Both were in Appalachia and had generally the same agricultural and labor history (former mining and lumber extraction with tobacco as the main crop). Both were more than 95% white and lost population over the last decade. Both had poverty rates around 20%, and median home values around $100,000. The resilient county had a work disability rate of about 20%, versus around 14% in the vulnerable county. The resilient county was considerably larger in terms of population (5–6 times), and was adjacent to a metropolitan area. The vulnerable county was a 2-h drive to the nearest metropolitan area. We first describe similarities between the two places and then move on to discussing community differences that may help explain overdose differences.

Respondents in both places reported similarities related to prescription opioid supply, including higher rates of opioid prescribing before a response to over-prescribing was mounted beginning in 2016. Participants also noted that proximity to a state border and lack of policing resources and interstate collaboration contributed to their problems, as did travel by non-local and out-of-state dealers to buy drugs for diversion. Both communities had been involved in successful prosecution of pharmacists and doctors violating criminal laws. Although unscrupulous pill mills had closed by 2018, there were still concerns about over-dispensing.

In both places, community members were skeptical of and concerned about federal and state government responses to medicalize the opioid problem, in particular needle distribution and medically-assisted treatment programs offering buprenorphine. They did not see these efforts as practical or culturally or politically feasible. Indeed, they were viewed as impediments to local efforts to combat drug use and revitalize poor areas. Residents of both places were in favor of strong injectable opioid antagonists as a method of treating severe addiction, especially as part of criminal justice supervision. Both places were concerned with a developing problem with buprenorphine use and abuse, a drug for the treatment of opioid addiction. Residents believed that it prevented people with addiction from “getting clean”, allowed users to supplement their drug habits at no-cost, and introduced new users to a softer form of opioids that was easy to obtain. Buprenorphine concerns centered on the amount being distributed locally, lack of proper screening and implementation, and use among youth. Respondents in both places were fearful of black market fentanyl and heroin, which were becoming problems in large cities in the region. However, both were most concerned with the local problem of powerful opioid pills such as oxymorphone hydrochloride. Recently, law enforcement in the resilient county sees user transition toward black market opioids and attributed this to the fact that diverted pill costs had increased locally.

Despite cultural, geographic and economic similarity on the most basic measures such as poverty and unemployment, there were economic differences between the two counties. The resilient county had capitalized on natural amenities to promote tourism-based economic development, albeit much of it in the low-paying service industry. The county has approximately a dozen fast-food restaurants, a small revitalizing downtown area with a few cafes and shops, grocery stores, a modern chain hotel and big box store, and scattered small businesses. The vulnerable county had almost none of these amenities, having only one family restaurant in town, no nearby hotels, and very little industry. The vulnerable place had few visible middle class homes, with the few professionals in the area tending to live outside town on small farms or wooded acreages.

In the resilient county, many local leaders were persons who had historical and family ties to the area and had spent part of their careers in other places, often larger cities, returning for affordability and quality of life. Professionals in the area seemed to form a large and tight network that extended to ties with federal and state agencies, allowing better access to resources. There was widespread recognition that managing the local opioid problem would have to be a comprehensive, involving many approaches, many local partners, and patience. Respondents in the resilient place also tended to better understand and accurately acknowledge that they have an opioid problem driven by structural factors and to want to address the problem. Participants in the resilient community pointed out that their community had been devastated by opioids and that the epidemic had touched most families. They pointed to many informal non-governmental organizations, mainly church-supported, that assisted people with addiction. They also pointed to local success stories people in recovery who were now community and religious leaders. Respondents embraced a culture of redemption in this religion-infused culture. We were struck by how many public officials reported volunteering to help with the opioid problem.

In the vulnerable county, we observed few indications that various levels of government were connected and mutually supportive. Local leaders did not cooperate with regional or state agencies. Local government officials were poorly trained and uninterested in learning best practices to address the problem. Participants in the vulnerable county tended to shift blame for their opioid problem to people with addiction and discounted the usefulness of programs to address addiction. For example, community leaders and law enforcement officers pointed to a sizeable public housing project constructed in the 1950s as the culprit of the county's drug problem. They stated that many outsiders moved in to take advantage of available government housing, and were not considered long-term residents of the community. The implication that the community was full of shiftless addicts was recurring, with one official noting that the best solution "would be a bus to ship them somewhere else." Officials felt hopeless in managing this population and the problems they believed had been imported with them. There was very little indication in the vulnerable county that people with addiction could change their lives, and there did not appear to be any community efforts to improve the problem. State welfare programs to help the low-to-moderate income residents, including free postsecondary technical education, were cast as misguided and hopeless investments that could never be accessed by residents of the troubled parts of this community. Participants living in the vulnerable county also begrudged that they had received national press attention for being an outlier in opioid overprescribing and overdoses, even though this had led to closure of several criminal prescribers.

There were also important community resource differences. The resilient county had a local hospital, with a major research hospital nearby. They developed extensive ties in the region to promote staff training, shared addiction programs, and provided alternative criminal justice programs to avoid incarceration. The criminal justice system was closely tied to other local agencies, state drug task forces, coroners, and healthcare and treatment professionals. In all but the most mountainous parts of the county, city officers, emergency personnel, teachers, and social workers reported that they always had Naloxone on hand.

By contrast, the vulnerable county had few ties to outside agencies or resources. There was no local hospital, as it had recently closed, and the nearest health care facility was a 50-min drive to the next county. Some officers reported carrying Naloxone, but it was used sparingly with a preference to wait for EMT arrival. Local emergency medical technicians (EMTs) reported delaying Naloxone administrations to keep opioid overdose victims unconscious during transport to the hospital to avoid potential violence from patients who were suddenly revived. There was some support from state and federal criminal justice agencies, but these ties did not seem stable or to be initiated by locals.

Conclusions

Despite recent declines in prescription opioid overdose mortality rates, rates remain higher in rural than in urban areas. However, rural communities are not homogenous, and while some rural communities have been vulnerable to the prescription opioid overdose crisis, others have capitalized on community resources to keep overdose rates lower than expected given other community risk conditions. Using both secondary analysis of opioid overdose rates and qualitative data from our two case study counties, we identified several potential explanations for why some rural places were resilient to the prescription opioid overdose crisis while others suffered high overdose rates (vulnerable). Our findings have important implications for policy and future research in geographic differences in drug overdose.

Using conventional statistical models, only 40% of the county-level variation in prescription opioid overdose deaths is accounted for by structural factors like demographic and socioeconomic composition, opioid supply, health status, and labor market factors. Based on regression models and the case studies, we find that high overdose resilient and vulnerable counties share common characteristics. Both are concentrated in states at the epicenter of the prescription opioid epidemic, particularly in Appalachia, and are majority white. The common pathway is work disability due to a legacy of mining and manufacturing and over-dispensing of prescriptions. In addition to prescription opioids, both resilient and vulnerable places also suffer from high rates of polysubstance drug overdose, notably methamphetamine, illicit opioids, and prescription sedatives and anti-depressants.

What distinguishes high overdose resilient places from vulnerable ones? We found that resilient places have larger populations anchored by a micropolitan city and are near metropolitan centers. Resilient places are also more mining intensive. One legacy of this is an existing healthcare infrastructure to treat black lung disease that both exacerbated the opioid epidemic, but also helped address it quickly. Greater access to medical clinics and pharmacies facilitated addiction, but greater availability of mental health, substance abuse, and social services facilitated treatment and recovery. Resilient communities appear to have repurposed black lung disease facilities and other social services to combat the opioid crisis, whereas such facilities were typically absent in smaller vulnerable communities. Indeed, the wealthier, larger churches and infrastructure associated with them in less remote places often provides a foundation for opioid related services ranging from housing, to food, to counseling.

In terms of social norms, resilient places accepted that people with addiction were part of the community, resulting in a community-wide mobilization to begin addressing the opioid crisis. Respondents exuded an ethic of redemption and forgiveness, where people in recovery were not stigmatized for past behavior. Rather such persons were given a measure of social prestige by staying sober, supporting their family, and giving their time to mentor others. By contrast, in vulnerable communities the ethic was one of recrimination and exclusion. Both people with current addiction and those in recovery were ostracized and not considered part of the community. There were no local efforts to provide services to this population, besides required emergency care or incarceration. Residents often mentioned the only viable solution to address the opioid problem was to shut down the public housing project and/or relocate people with addiction to other counties. People with addiction were viewed as second-class citizens with little value. Not only were they denied medical care (e.g., delays in Naloxone administration), but they were economically excluded, socially isolated, and physically segregated – all hindering the probability of successful recovery.

Secondary analysis of mortality data has provided important insights into the place-level factors that have driven geographic differences in drug overdose rates. However, there is often sizable variation left unexplained by unobserved variables that cannot be included in regression models. A closer examination of cases that are poorly fitted by regression models can inform research by uncovering omitted variables present in existing secondary data, identifying new and unmeasured concepts to guide future data collection, or improving mixed-methods research by empirically identifying study sites for case studies. Understanding poorly fitted places has potential to inform public health practice by elucidating effective strategies. It is important to remember opioid crisis has not abated in high overdose resilient places, rather these resilient communities are doing better than other vulnerable places with similar risk conditions. For example, resilient places may have developed innovative programs, unique collaborations, or pro-social community norms that tempered the opioid crisis. By contrast, places doing worse than predicted provide examples of what not to do or demonstrate the consequences of inaction. If there is one general policy conclusion it is that when remote communities face large problems, it will take greater investment to address given the additional disadvantage of distance to resources. Our current policies based on local governance and targeting resources to more accessible and usually larger rural places by state and national policy-makers, neglects the barriers confronting such communities. A more proactive law enforcement and public health response from outside government is called for in communities that simply cannot access available programs if for no other reasons than they lack contacts and professional grant writers.

Research on explanations for geographic differences in prescription opioid overdoses has probably reached a limit on what can be further learned from county-level secondary data analysis. To gain additional insights, researchers will likely need to employ mixed-method approaches to better understand the complex interactions between community structures and local agency. Our study is a first step. One limitation is that it is restricted to prescription opioid overdoses, and the findings may not apply to the worsening illicit opioid crisis.

Appendix

Table 2 Odds Ratios from Negative Binomial Model Predicting Prescription Opioid Overdose Mortality in 2016–18 Using 2010 Covariates for $N = 2{,}013$ Non-Metropolitan Counties in the Conterminous United States

	2010 Covariates			2010 Covariates and Change from 2000		
	OR	95% CI	*P*	OR	95% CI	*P*
Intercept (b_0)[a]	0.236	(-1.159–1.630)	.741	1.490	(-0.302–3.828)	.103
Population (1 k)	0.999	(0.996–1.002)	.604	0.999	(0.995–1.002)	.439
Age 25 and younger (%)	1.016	(0.992–1.040)	.193	1.000	(0.970–1.030)	.990
Age 65 and older (%)	1.022	(0.995–1.050)	.113	1.022	(0.992–1.054)	.153
Hispanic, any race (%)	0.998	(0.990–1.005)	.505	1.000	(0.992–1.008)	.928
African American (%)	0.985	(0.977–0.993)	< .001	0.987	(0.978–0.995)	.002
Other or multiple races (%)	1.012	(1.003–1.021)	.010	1.013	(1.003–1.024)	.011
New residents within last year (%)	1.018	(0.993–1.043)	.154	1.016	(0.990–1.042)	.238
Urban influence code (1–12)	0.987	(0.963–1.012)	.318	0.981	(0.956–1.007)	.144
Interstate density (sq.mi.*100)	1.004	(0.976–1.034)	.763	1.002	(0.974–1.031)	.873
Poverty (%)	0.997	(0.981–1.012)	.680	0.990	(0.969–1.011)	.351
Vacant housing units (%)	1.000	(0.992–1.008)	.978	1.001	(0.993–1.01)	.799
Property crimes (per 100 k)	1.000	(1.000–1.000)	.653	1.000	(1.000–1.000)	.364
Religious org. jobs (per 10 k)	0.997	(0.995–0.999)	.013	0.995	(0.992–0.998)	.002
Community & social org. jobs (per 10 k)	0.998	(0.995–1.001)	.278	0.997	(0.993–1.001)	.195
Work related org. jobs (per 10 k)	1.003	(0.995–1.011)	.434	1.005	(0.996–1.014)	.306
Media org. jobs (per 10 k)	0.994	(0.988–0.999)	.030	0.993	(0.987–1.000)	.034
Non-opioid OD deaths (per 100 k)	1.017	(1.006–1.028)	.002	1.016	(1.005–1.027)	.004
Rx Opioid OD deaths (per 100 k)	1.019	(1.007–1.031)	.002	1.021	(1.009–1.033)	< .001

Table 2 (continued)

	2010 Covariates			2010 Covariates and Change from 2000		
	OR	95% CI	*P*	OR	95% CI	*P*
Illicit Opioid OD deaths (per 100 k)	1.023	(1.004–1.042)	.015	1.021	(1.003–1.040)	.024
Rx opioid dispensing 2010–12 (per 100)	1.002	(1.000–1.004)	.014	1.002	(1.000–1.003)	.048
Work disabled population (%)	1.055	(0.978–1.138)	.167	1.131	(1.017–1.257)	.023
Retail pharmacy jobs (per 10 k)	1.003	(0.998–1.007)	.257	1.006	(1.000–1.012)	.065
Physician office jobs (per 10 k)	1.000	(0.998–1.002)	.799	1.001	(0.998–1.003)	.716
Mental health/substance abuse jobs (per 10 k)	1.000	(0.999–1.001)	.568	1.000	(0.999–1.001)	.967
Hospital jobs (per 10 k)	1.000	(0.999–1.000)	.483	1.000	(0.999–1.000)	.172
Family social services jobs (per 10 k)	1.000	(0.999–1.001)	.946	1.001	(0.999–1.002)	.420
Agriculture, forestry & fishing (%)	0.977	(0.961–0.993)	.005	0.965	(0.946–0.985)	< .001
Mining (%)	1.001	(0.982–1.020)	.934	0.976	(0.949–1.004)	.095
Manufacturing (%)	0.998	(0.984–1.011)	.729	0.992	(0.977–1.008)	.323
Construction (%)	0.952	(0.927–0.978)	< .001	0.948	(0.913–0.984)	.005
Transportation & warehousing (%)	0.999	(0.962–1.038)	.972	0.979	(0.931–1.030)	.413
Retail trade & leisure services (%)	1.011	(0.995–1.028)	.182	1.004	(0.983–1.027)	.694
Change 2000–2010						
Population[b]	*n.a*	*n.a*		0.997	(0.988–1.006)	.534
Age 25 and younger	*n.a*	*n.a*		1.041	(0.993–1.092)	.095
Age 65 and older	*n.a*	*n.a*		0.935	(0.891–0.982)	.007
Hispanic, any race	*n.a*	*n.a*		0.994	(0.962–1.026)	.687
African American	*n.a*	*n.a*		0.952	(0.910–0.995)	.029
Other or multiple races	*n.a*	*n.a*		1.013	(0.967–1.063)	.578

Table 2 (continued)

	2010 Covariates			2010 Covariates and Change from 2000		
	OR	95% CI	*P*	OR	95% CI	*P*
New residents within last year	*n.a*	*n.a*		1.000	(0.983–1.018)	.973
Poverty	*n.a*	*n.a*		1.005	(0.981–1.030)	.684
Vacant housing units	*n.a*	*n.a*		0.991	(0.973–1.010)	.370
Property crimes	*n.a*	*n.a*		1.000	(1.000–1.000)	.382
Religious org. jobs	*n.a*	*n.a*		1.002	(0.998–1.006)	.289
Community & social org. jobs	*n.a*	*n.a*		1.001	(0.997–1.005)	.588
Work related org. jobs	*n.a*	*n.a*		0.995	(0.986–1.004)	.266
Media org. jobs	*n.a*	*n.a*		0.999	(0.993–1.004)	.631
Work disabled population	*n.a*	*n.a*		0.854	(0.706–1.033)	.104
Retail pharmacy jobs	*n.a*	*n.a*		0.995	(0.989–1.002)	.151
Physician office jobs	*n.a*	*n.a*		1.000	(0.997–1.003)	.982
Mental health/substance abuse jobs	*n.a*	*n.a*		1.001	(0.999–1.002)	.599
Hospital jobs	*n.a*	*n.a*		1.001	(1.000–1.002)	.283
Family social services jobs	*n.a*	*n.a*		0.999	(0.997–1.001)	.222
Agriculture, forestry & fishing	*n.a*	*n.a*		1.046	(1.015–1.077)	.004
Mining	*n.a*	*n.a*		1.056	(1.002–1.113)	.044
Manufacturing	*n.a*	*n.a*		1.010	(0.989–1.032)	.342
Construction	*n.a*	*n.a*		1.010	(0.969–1.052)	.640
Transportation & warehousing	*n.a*	*n.a*		1.036	(0.981–1.094)	.201
Retail trade & leisure services	*n.a*	*n.a*		1.015	(0.991–1.041)	.225
Statistical and Spatial Controls						
Spatial Lag (Queens)	1.023	(0.990–1.056)	.173	1.024	(0.991–1.058)	.157

Table 2 (continued)

	2010 Covariates			2010 Covariates and Change from 2000		
	OR	95% CI	*P*	OR	95% CI	*P*
Dispersion[a]	1.011	(0.909–1.124)	< .001	0.969	(0.870–1.079)	< .001
State Fixed Effects	Yes	*n.a*		Yes	*n.a*	
-2LL	8491.913			8441.491		
pR^2	0.398			0.401		
$\chi^2_{Pearson}$	2642.224		*df = 1939*	2569.869		*df = 1913*

Mortality rate (age-adjusted) per 100,000 people

OR odds ratios; *CI* confidence interval; two-tailed tests; *a* estimate; *b* percent change

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