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The National Drug Crisis - What Have We Learned from the Regional Science Disciplines?*

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Abstract: Brian Cushing's Presidential Address for the Southern Regional Science Association (Cushing, 2017) detailed the U.S. drug crisis, including the high cost in terms of lost lives and financial costs. After determining almost no participation in drug crisis research by the regional science community, he charged regional scientists to learn about the crisis and become part of the discussion. In the few years since that address, the drug crisis has continued to accelerate. This time, however, regional science scholars have stepped up to conduct research and become part of the policy discussions. We update Cushing's (2017) discussion with new details regarding the worsening crisis. We then document and discuss the "regional science" contributions to the ongoing drug crisis literature. We finish with thoughts regarding what regional scientists doing research on the drug crisis should consider going forward.

Keywords: regional, rural, mortality, drug crisis

JEL Codes: I15, O18, R10

1. INTRODUCTION

In fall 2016, as Brian Cushing began writing his SRSA Presidential Address, "A Role for Regional Scientists in a Time of Crisis" (Cushing, 2017), the United States was just beginning to come to terms with the drug crisis that was killing tens of thousands of people each year, overwhelming parts of the emergency response and health care systems, and devastating many localities. Cushing began his address with an overview of the drug crisis from a national perspective, focusing on drug-overdose mortality. His analysis included a detailed timeline for the developing crisis and its eventual surge, information on the changing mix

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of drugs behind the crisis, important demographics of those affected, and estimates of the cost to the nation. He then turned to analysis at the state and local level to demonstrate the substantial spatial heterogeneity in the magnitude of the problem. He illustrated the concentration of high drug mortality rates in rural areas, including much of Appalachia, with Central Appalachia being one of the early centers of the drug crisis – perhaps "ground zero" for the opioid crisis that began its explosive growth in the late 1990s.

Despite the highly spatial nature of the U.S. drug crisis, including its disproportionate concentration in rural areas, Cushing found little evidence of regional science research on what had developed into one of the major health, social, and economic crises of our time. Looking through the previous ten years of a dozen journals that could be considered the core journals of the regional science discipline, he did not find any papers on the drug crisis. He also found little evidence of regional/spatial analysis of the drug crisis in a wide range of other journals. The only evidence of regional/spatial research was a few scattered presentations at recent North American Regional Science meetings or Southern Regional Science Association meetings. He ended with the following challenge to the regional science community:

> "I believe regional scientists have valuable skills to bring to the table, including regional analysis skills, spatial analysis skills, interdisciplinary pedigree, and many with a deep understanding regarding the nature and dynamics of the rural economy, particularly in Appalachia. I hope our scholars will step up to the table to share knowledge and skills that might help some of these places move forward."

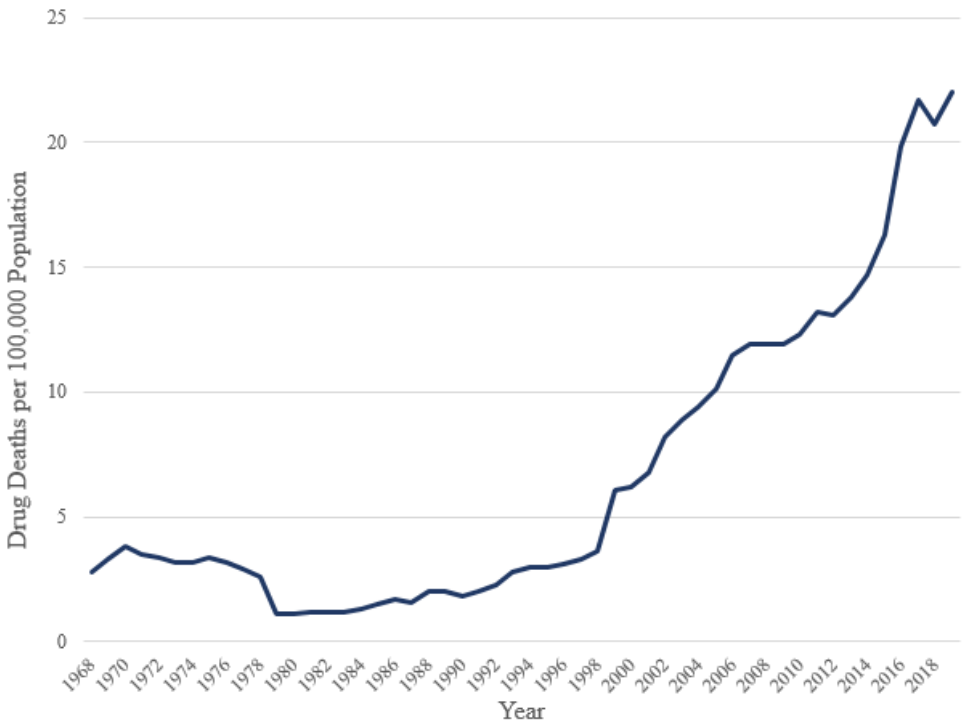
The remainder of this paper revisits Cushing's Presidential Address. First, we provide an update on the drug crisis as it has played out since the original paper was written in 2017. Then we document and summarize the rapidly expanding research taking place within the regional science community of scholars. Even greater commitment by the regional science community cannot come soon enough. The once regional drug crisis initially fueled by the combination of high-injury jobs and easy access to prescription opioids in parts of rural America has exploded into a major national crisis. The current opioid crisis does not discriminate based on type of employment or type of place. Mortality rates continue to rise to new heights, even as prescription opioid abuse declines. This has exacted economic and social costs that are difficult to fathom.

2. UPDATE ON THE U.S. DRUG CRISIS

2.1. National Trends in Overall Drug-Overdose Mortality

As described in (Cushing, 2017) and shown in Figure 1, drug overdose mortality in the U.S. was modest and relatively stable from 1968 through most of the 1990s. Age-adjusted drug overdose mortality rates decreased during part of this period before slowly increasing during the 1990s, but remained below 4.0 per 100,000 population through 1998. Between 1998 and 2006, mortality increased by 250 percent from 9,838 to 34,425, with the age-adjusted rate increasing from 3.6 per 100,000 to 11.5. The drug mortality increase slowed for several

Figure 1: Annual Age-Adjusted Rate of Drug Deaths per 100,000 Population in U.S., 1968-2019

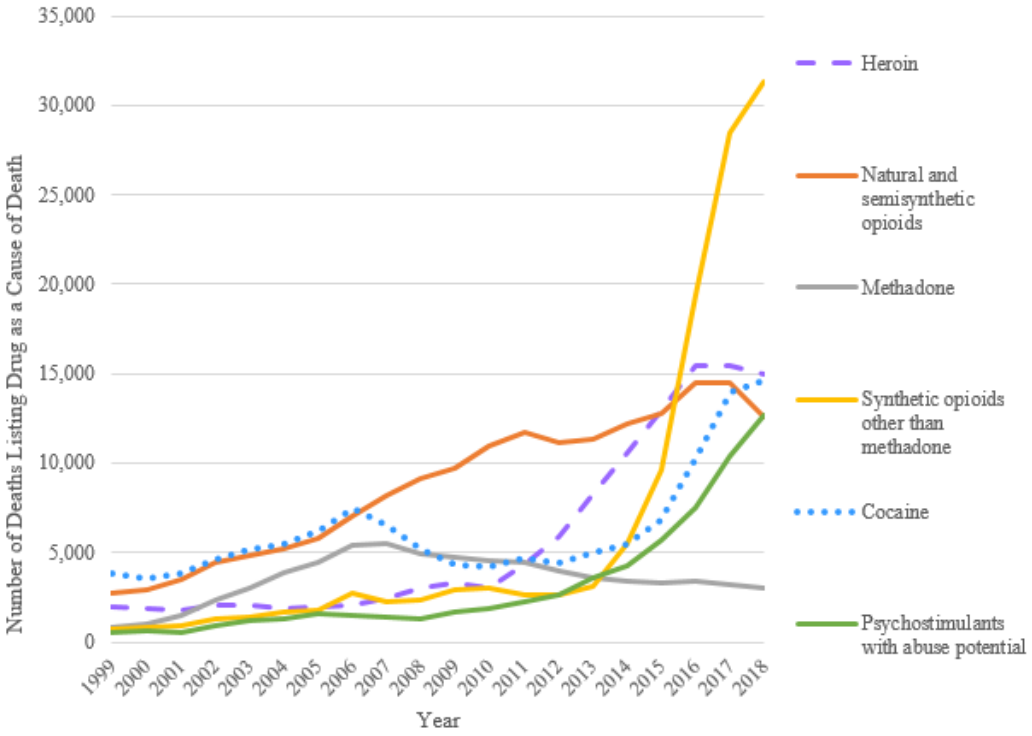


Note: Deaths are classified using the International Classification of Diseases, 10th Revision. Drug-poisoning (overdose) deaths are identified using underlying cause-of-death codes X40–X44, X60–X64, X85, and Y10–Y14. Authors estimate 2019 based on National Center for Health Statistics (NCHS) provisional data. Sources: 1968-2018 - CDC Wonder, National Centers for Disease Control and Prevention. 2019 Drug overdose mortality - Ahmad FB, Rossen LM, Sutton P. "Provisional drug overdose death counts," National Center for Health Statistics. 2020, https://www.cdc.gov/nchs/nvss/vsrr/drug-overdose-data.htm. 2019 Population Data - U.S. Bureau of the Census, July 1 estimate

years but surged again after 2012. At the time Cushing finished his original paper, the nation recorded a stunning 22 percent year-over-year increase in overdose mortality to 64,000 deaths for 2016, with an age-adjusted rate of 19.8 per 100,000 population. The total was well above the number of deaths from automobiles or guns. In 2017, drug mortality surpassed 70,000, with an age-adjusted death rate of 21.7. The year 2018 provided a ray of hope with annual drug overdose deaths declining for the first time since 1990, though the decline was just to 67,367, the second highest annual total ever. The optimism was short-lived, however, with preliminary estimates indicating a 6.8 percent year-over-year increase in drug overdose mortality to a record 71,966 for 2019 (Ahmad et al., 2020).

Early information indicates a potentially substantial increase in drug overdose mortality for 2020. Based on the latest available preliminary monthly estimates, Ahmad et al. (2020) predict drug overdose mortality of 75,588 for the 12 months ending March 31, 2020, a ten percent increase compared with the same 12 months ending March 31, 2019. Based on data collected from state and local governments, covering about 40 percent of the U.S. population, the New York Times showed an average increase of 13 percent in drug overdose mortality

Figure 2: U.S. Drug-Overdose Deaths by Type of Drug, 1999-2018



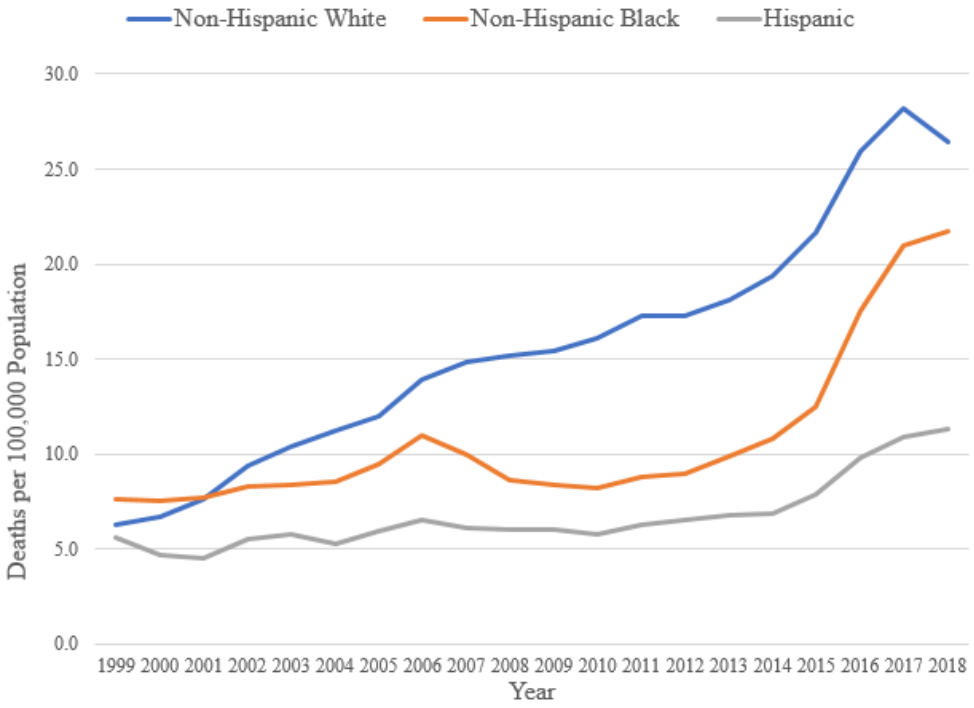
Source of Data: CDC Wonder, National Centers for Disease Control and Prevention

through the first part of 2020 (Katz et al., 2020). In New Jersey, drug-related deaths were up 17 percent during the first half of 2020 compared with the same period in 2019. In Colorado, drug-related deaths were up 30 percent for the first three months of 2020 compared with 2019. Much of this preliminary information is for pre-pandemic months. Experts are concerned that the COVID-19 pandemic has resulted in a significant additional increase in mortality. Experts believe that coronavirus-related isolation has kept addicted individuals away from their support networks and in-person treatment options. In addition, some believe that the coronavirus itself has triggered people to cope by turning to drugs. In early October 2020, the American Medical Association said that more than 40 states had reported increases in opioid-related mortality (Jasper, 2020).

2.2. National Trends in Mortality by Drug Type

At the time of Cushing's (2017) analysis, prescription opioids other than methadone (natural and semi-synthetic opioids) and heroin were the two most common causes of drug overdose mortality in the U.S., with each involved in about 25 percent of overdose deaths for 2015 (Figure 2). Government policies were slowing the rise of prescription drug overdose deaths, but growth in the use of (inexpensive) heroin had fueled much of the rapid rise in mortality after 2011-2012. Illicit fentanyl was just emerging as a major cause of drug overdose mortality

Figure 3: Age Adjusted Drug-Overdose Mortality Rates by Race and Hispanic Origin, 1999-2018



Source of Data: CDC Wonder, National Centers for Disease Control and Prevention

– involved in 18 percent of overdose deaths in 2015.[1] Fentanyl is considered to be 50 times more potent than heroin and as much as 100 times more potent than morphine.[2]

The next three years saw important shifts in these patterns. Between 2015 and 2018, U.S. drug overdose deaths increased by 29 percent. During this period, deaths with heroin listed as a cause increased by 15 percent, while deaths connected to prescription opioids (methadone, as well as other natural and semi-synthetic opioids) leveled off before decreasing. Deaths connected to fentanyl increased by 227 percent. In addition, cocaine and methamphetamines (the main addictive psychostimulant), re-emerged as major deadly drugs. Drug overdose deaths connected to these increased by 116 percent and 122 percent, respectively between 2015 and 2018. In 2018, 47 percent of drug overdose deaths (more than 31,000) listed fentanyl as a cause, with heroin and cocaine each listed in 22 percent of deaths, and prescription opioids (other than methadone) and psychostimulants (mainly methamphetamine) each listed in 19 percent of deaths. Heroin and cocaine are often laced with fentanyl, thus contributing to their importance as causes of drug overdose mortality.

[1]Though fentanyl is prescribed as a very powerful pain medication for extreme pain, such as from cancer, experts have concluded that almost all fentanyl-related overdose deaths are from illicit fentanyl manufactured in and imported from other countries. See https://www.cdc.gov/drugoverdose/opioids/fentanyl.html.
[2]See https://www.cdc.gov/drugoverdose/data/fentanyl.html.

2.3. National Trends in Mortality by Race and Hispanic Origin

As noted in Cushing (2017), unlike previous drug crisis episodes in the U.S., this crisis has had its greatest effect on the non-Hispanic white population (Figure 3). Between 1999 and 2011, the non-Hispanic white mortality rate surged by 175 percent to 17.3 per 100,000 population. During this same period, the non-Hispanic black mortality rate increased by 16 percent to 8.8, 49 percent below the white mortality rate. The Hispanic mortality rate increased by just 13 percent to 6.3, 64 percent below the non-Hispanic white mortality rate.

This pattern has changed in recent years for the black population, mostly since 2015. Non-Hispanic white mortality increased rapidly for two years, before declining in 2018. Mortality for the Non-Hispanic black population surged by 68 percent in just two years before rising modestly in 2018, leaving the mortality rate (21.7) just 18 percent below that for the non-Hispanic white population (26.4). After increasing significantly during the last three years, Hispanic drug overdose mortality for 2018 was 11.3, high compared with earlier years, but still 57 percent below the non-Hispanic white mortality rate. We will return to this pattern change below.

2.4. National Trends in Mortality by Urban-Rural Classification

For many, first awareness of the national drug crisis was connected with rural America. Central Appalachia and some surrounding counties were considered by some as "ground zero" for the drug crisis, especially the vicinity of Central Appalachia:

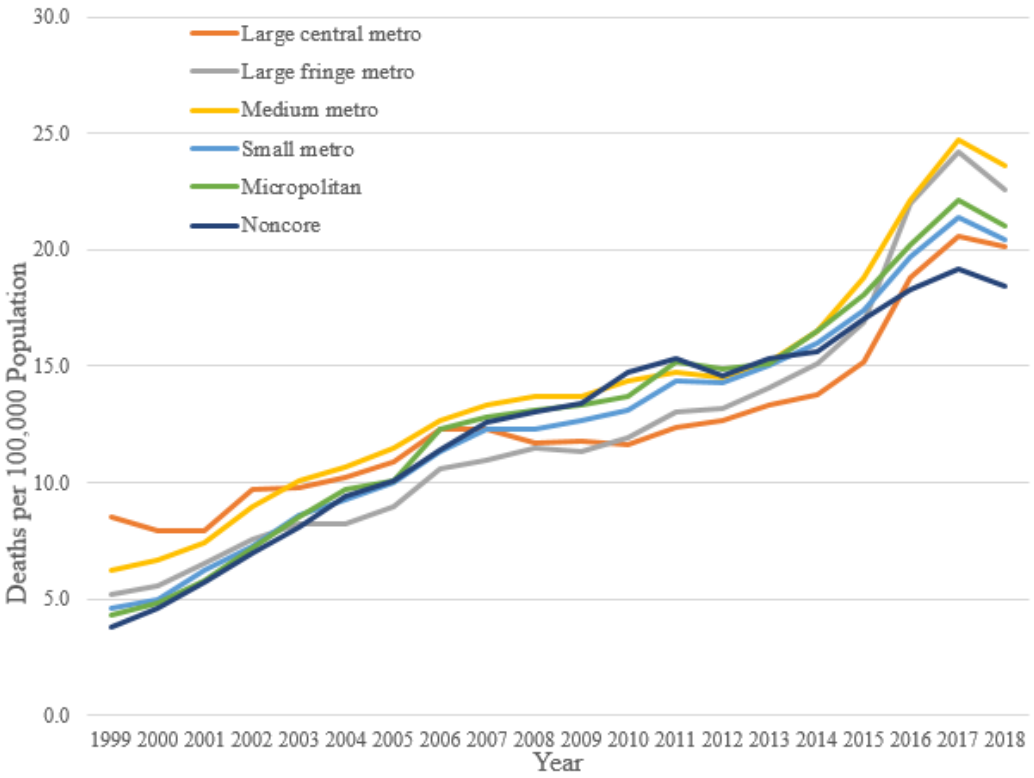
> "Nearly two decades ago, a large swath of counties that basically includes all of Central Appalachia, plus many nearby Appalachian counties in West Virginia and Tennessee, formed the core of the early stages of the current drug crisis. These counties had rates of drug use and overdose deaths that would be considered high even by today's standards. During these 20 years, this region has continued to have among the highest rates of drug abuse and drug overdose deaths." (Cushing, 2017, p. 232)

Just as the patterns and trends related to other characteristics have changed over time, the distribution across the urban/rural landscape has varied greatly during the past 20 years. Figure 4 shows drug-overdose mortality by Urban-Rural Classification type. This is based on the 2013 vintage of the National Center for Health Statistics (NCHS) "Urban-Rural Classification Scheme" (see https://www.cdc.gov/nchs/data_access/urban_rural.htm). This classifies counties based on size and urban clustering, from central counties of MSAs of at least one million people (large central metro) down to small nonmetro counties with no urban cluster of at least 10,000 people (noncore). Key features of this chart are:

1) Noncore counties had the lowest drug mortality rates in 1999, experienced rapidly increasing mortality early on (fueled by the prescription opioid crisis), and had the highest mortality rates in the 2010-2013 period (2nd highest in 2012) but ended with the lowest drug mortality rates in 2016-2018.

2) Micropolitan counties (nonmetro county with an urban cluster of 10,000 to 49,999 people)

Figure 4: Age Adjusted Drug-Overdose Mortality Rates by Urban-Rural Classification Type, 1999-2018



Source of Data: CDC Wonder, National Centers for Disease Control and Prevention

had much the same pattern as noncore counties but finished with a much higher trajectory than noncore counties.

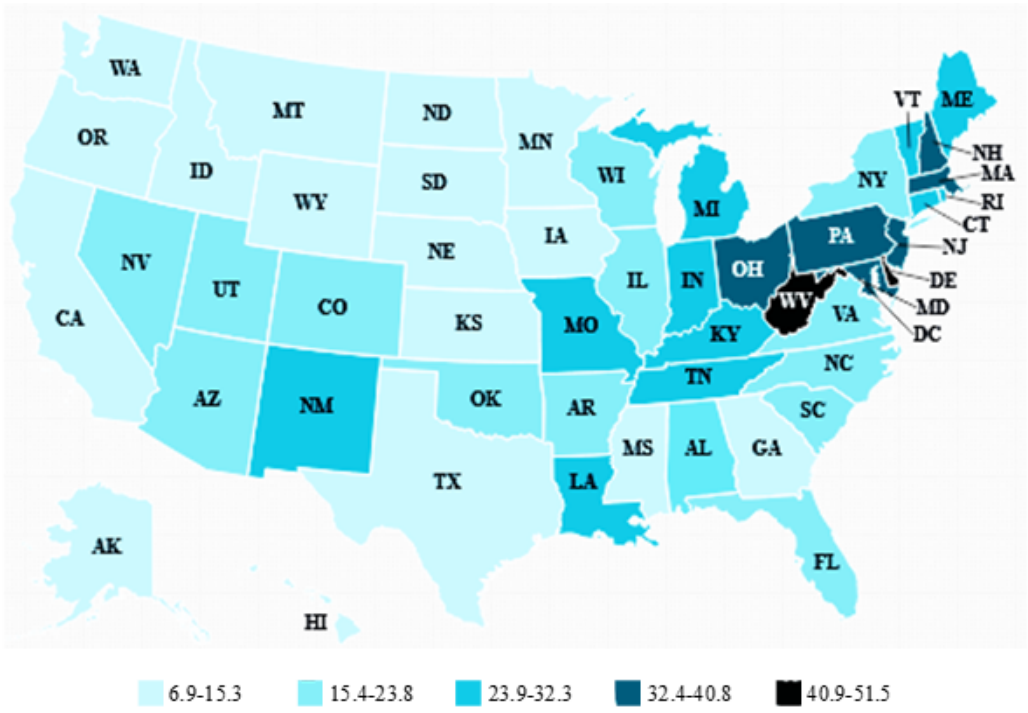
3) Large central metro counties (considered by NCHS as a "central county" of an MSA of at least 1 million people) began with the highest drug mortality rates, experienced a flatter trajectory of mortality throughout most of the next 19 years, and then experienced a rapid increase in 2016 and 2017.

4) Large fringe metro counties (within MSA of at least 1 million people, but not a "central county") experienced a consistent, but moderate upward trajectory in mortality through 2012, with among the lowest mortality rates in the middle portion of the period, followed by the most rapid increase in mortality after 2012, leaving them with among the highest mortality rates in the end.

5) Medium metro counties (within metro area or 250,000 to 999,999 people) also experienced an almost constant moderate upward trajectory, but with among the highest mortality rates except in the middle years before finishing with a rapid upward trajectory and the highest mortality rates every year after 2013.

The rapidly increasing mortality in the three most urban county types during the later years is consistent with the narrowing gap between non-Hispanic white and non-Hispanic black mortality that began after 2012 and declined substantially after 2015. This trend to-

Figure 5: Age-Adjusted Drug-Overdose Mortality Rates (per 100,000 Population) for U.S. States, 2018



Source: Kaiser Family Foundation, "State Health Facts," https://www.kff.org/other/state-indicator/opioid-overdose-death-rates/

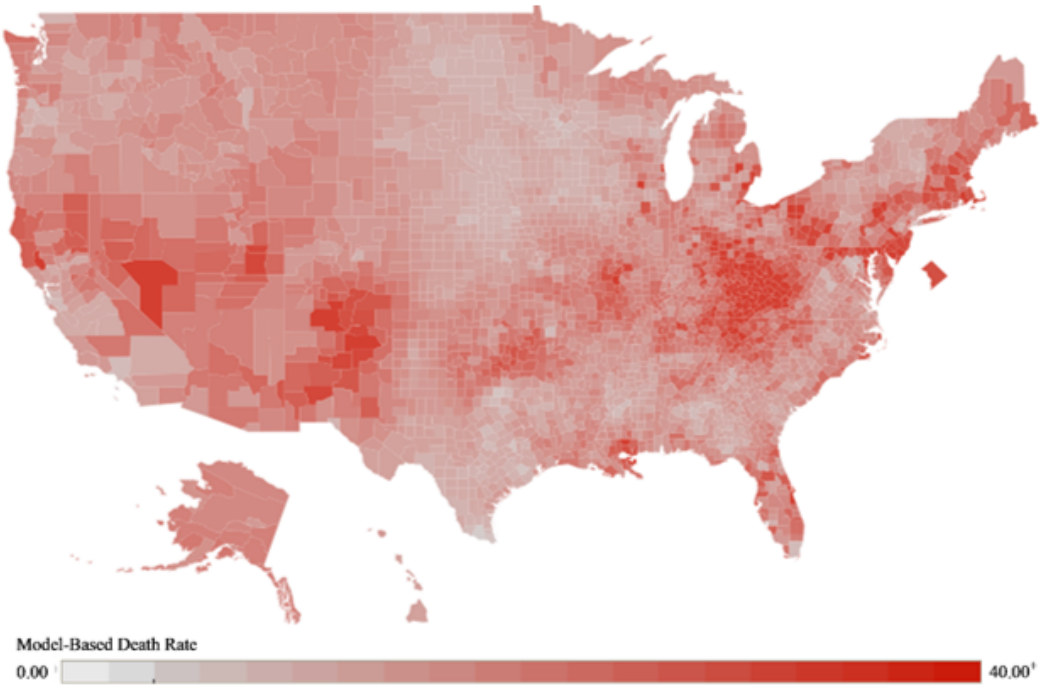
ward more urbanization of the drug crisis likely contributed to the increasing public awareness and policy response after 2012.

2.5. State Trends and Patterns in Mortality Rates

Figure 5 illustrates drug mortality rates by state for 2018. No matter which year was selected during the 1999-2018 period, this map shows a cluster of high-mortality states centered around Appalachia, as well as a cluster of relatively high mortality states in the southwest U.S. The large (and growing) cluster of high drug-mortality states in the eastern U.S. has resulted primarily from access to fentanyl, which has been primarily an eastern U.S. issue.[3] In 2018, the 15 states with the highest mortality rates from fentanyl, and 24 of the highest 25 states, were states east of the Mississippi River. Fentanyl was just beginning to alter the trajectory of drug mortality in the western U.S. at the end of the 1999-2018 period. The rapid increase in cocaine mortality in the last few years (see Figure 2) was also primarily an eastern U.S. problem, and especially for the large fringe metro and medium metro counties, which experienced the most rapid increase in drug-overdose mortality late in the period (see Figure 4). On the other hand, the increase in mortality from methamphetamine was almost exclusively an issue for western states, until a recent surge in the east, especially in West

[3]All statistics in this section for individual drugs comes from https://wonder.cdc.gov/mcd.html.

Figure 6: Heat Map for U.S. County Drug Overdose Mortality, 2018



Notes: Washington, DC shown (off the east coast) as an insert, to distinguish its heat map color. The deepest color is for any county with a mortality rate of 40.00 or more.
Source: https://www.cdc.gov/nchs/data-visualization/drug-poisoning-mortality/index.htm

Virginia and Kentucky. In 2018, West Virginia's mortality rate from methamphetamine of 19.3 was nearly twice the rate of any other state in the country.

2.6. County Mortality Rates

As made clear in Cushing (2017), interstate variation in drug-overdose mortality only begins to tell the story of the spatial distribution of drug mortality across the U.S. Figure 6 is a "heat map" illustrating county-level drug mortality rate estimates for 2018. The deepest red colors signify a drug mortality rate of at least 40 per 100,000. The map reveals substantial spatial heterogeneity within, as well as across, states. The map shows a large concentration of high drug-mortality counties in Appalachia, especially in West Virginia, Kentucky, and southern Ohio. Another concentration of high drug-mortality counties sits in the southwest (primarily in Arizona, New Mexico, and Nevada). We also see a large concentration in the metro areas along the eastern seaboard, north of Virginia. Though not shown, this same heat map for 2014 only has deep red in the Central Appalachia area and a couple counties in the southwest U.S. This dramatic change in the map reflects what the previous sections have shown: a rapid rise in overdose mortality driven by a surge in fentanyl-related deaths (as well as a rise in cocaine-deaths) in the eastern U.S., with a surge in non-Hispanic black mortality and a surge in drug mortality in metro areas.

From the data behind what would be the 2014 heat map, the 40 counties with the highest estimated drug-overdose mortality rates had rates that ranged between 36.5 per 100,000 and 71.5 per 100,000. Of these, 38 were east of the Mississippi River (one each in New Mexico and California), with 30 located in West Virginia or Kentucky. Twenty-seven of 40 were part of the Central Appalachia subregion, with an additional six counties bordering on Central Appalachia. The 40 included 31 nonmetro counties (26 noncore and 5 micropolitan), just one large central metro county (Baltimore City), and four large fringe metro counties – all part of the Cincinnati, OH-KY-IN metro area. The mostly rural Central Appalachia vicinity was still the center of the growing drug crisis in the U.S. in 2014.

From the data used for Figure 6, the 40 counties with the highest estimated drug-overdose mortality rates had rates that ranged between 49.4 per 100,000 and 106.6 per 100,000. The other important difference between the 2014 data and the 2018 data is the much greater diversity of counties with high drug mortality rates. Of the 40 counties, 37 were east of the Mississippi River, with 22 located in West Virginia or Kentucky. Sixteen of 40 were part of the Central Appalachia subregion, with an additional seven counties bordering on Central Appalachia. The remaining 17 counties were from 11 different states and a much different size distribution compared with 2014. Baltimore City, MD, St. Louis City, MO, Philadelphia County, PA, and Camden County, NJ were ranked 1st, 7th, 13th, and 17th, respectively, for drug overdose mortality rates. The group of 40 counties includes seven large fringe metro counties and eight medium metro counties.

The drug crisis continues to grow and change in the U.S. It is no longer primarily a rural issue. It is a major issue for both, rural America and urban America. All indications are that the worst is yet to come.

2.7. Economic Cost of the U.S. Drug Crisis

The Council of Economic Advisers (CEA) 2017 conducted the most comprehensive study regarding the economic cost of the U.S. drug crisis. The CEA determined that previous estimates of the economic cost of the opioid crisis greatly understate the actual cost. They accounted for the worsening of the crisis, the increasing role played by heroin abuse, fatality statistics that understated the number of opioid-related deaths, and nonfatal costs of opioid misuse. The CEA estimated that, in 2015, the economic cost of the opioid crisis was $504.0 billion, or 2.8 percent of U.S. GDP that year.

Betz et al. (2020) estimated that drug abuse cost Americans $10.532 trillion from 1999 to 2016, an average of about $585 billion per year, though costs were lower at the beginning and increased substantially over time, peaking at $851 billion for 2016, about 4.5 percent of U.S. GDP. The main focus of their study, however, was on six Appalachian states (Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia) that accounted for 23 percent of all U.S. drug overdose deaths in 2017, despite having just 14 percent of the U.S. population. They estimated total drug-related costs for these six states to be $191.2 billion in 2016, which amounted to 7.8 percent of GSP for these six states. As shocking as these cost estimates might seem, the authors had good reason to believe that these estimates significantly understated the cost of the crisis in the U.S.

Costs for opioid use disorder and fatal opioid overdose in 2017 were estimated to be $1.02 trillion (Florence et al., 2020). The majority of the economic burden is due to reduced quality of life from opioid use disorder and the value of life lost due to fatal opioid overdose.

The U.S. drug-overdose mortality rate increased by about 35 percent since the 2015 basis for the CEA cost estimates and by about 11 percent since the 2016 basis for the Betz et al. estimates. As already noted, current evidence suggests that drug-overdose mortality has increased substantially during 2020. Thus, the total costs and costs as a percent of GDP (or GSP for states) has likely increased sharply during the past few years.

Ropero-Miller and Speaker (2019) address hidden costs from the drug epidemic. In particular, they walk through hidden costs for the forensic sciences service industry. Among the services provided by forensic labs are analysis of drugs captured during drug seizures and toxicology reports related to crimes. These have surged during the drug crisis, leading to a substantial overall demand for forensic services as the drug crisis has ramped up. Because budgets have not been expanded accordingly, their other services, such as analysis of rape kits, have slowed down significantly. Though difficult to quantify, this slowing of the wheels of justice imposes nontrivial emotional and financial costs.

2.8. Epilogue

We have a major crisis, built over time from a subnational level, with a clear spatial/regional character and important economic and social aspects, and with its "ground zero" in the heart of the Appalachian Region. As illustrated in many places above, this crisis is now in the midst of a rapidly changing spatial/regional dynamic. Because the drug crisis seems tailor-made for regional/spatial analysis, Cushing (2017) lamented the apparent lack of participation of the regional science community in drug-crisis-related research and policy analysis. At the time the address was written, conference papers by O'Connor (2016) and Erfanian et al. (2019) were the only evidence of regional science involvement. The next section documents research on the U.S. drug crisis from the regional science community in recent years. We follow this with a brief review of relevant regional/spatial research on the drug crisis since Cushing (2017). In the sections below, we define the "regional science community" or "regional science scholars" to include those who have either published in one of what we consider the 12 core regional science journals or presented a paper at a regional science conference in recent years.

3. CONTRIBUTIONS FROM REGIONAL SCIENCE

3.1. Regional Science Conference Sessions

Research on the U.S. drug crisis did not appear at regional science conferences until 2017, when Elham Erfanian and Frank O'Connor presented papers at the Annual Meetings of the Southern Regional Science Association (SRSA) and Elham Erfanian and David McGranahan presented papers at the North American Meetings of the Regional Science Association International (RSAI). Following up on Cushing (2017), organized sessions on the drug crisis have been part of the SRSA Meetings and the North American Meetings each year since

2017. During 2018 and 2019, 33 papers were presented in special sessions on the drug crisis at the SRSA and North American Meetings, along with five other stand-alone paper presentations at other regional science conferences in North America – one each at the 2018 and 2019 North American Meetings and three at the 2019 Western Regional Science Association (WRSA) Meetings (see Table 1). Special sessions with five paper presentations and a panel discussion were scheduled for the April 2020 SRSA conference that, ultimately, was canceled due to COVID-19.

3.2. Regional Science Journal Publications

As in Cushing (2017), we considered a dozen journals as the core regional science journals: *Annals of Regional Science*, *Growth and Change*, *International Journal of Urban and Regional Research*, *International Regional Science Review*, *Journal of Regional Analysis and Policy*, *Journal of Regional Science*, *Journal of Urban Economics*, *Papers in Regional Science*, *Regional Science and Urban Economics*, *Regional Studies*, *Review of Regional Studies*, and *Urban Studies*. Aside from Cushing (2017), we found three relevant papers:

Bondurant, Lindo, and Swensen. (*Journal of Urban Economics*, 2018)

Erfanian, Collins, and Grossman (*Review of Regional Studies*, 2019)

Gihleb, Giuntella, and Zhang (*Regional Science and Urban Economics*, 2020)

With the growing awareness of the magnitude and consequences of the crisis and the uptick in research presented at regional science conferences, we expect this to change in the near future.

3.3. Regional Science Contributions to Other Journals

A number of regional science scholars have published papers on the drug crisis in other relevant journals, often in journals focused on substance abuse. These are listed below. For this purpose, we consider them connected to regional science if the author either presented at one of our regional science conferences or is considered part of our regional science community of scholars, even if the particular paper was not presented at a regional science conference. In the list below the regional science scholar is listed in parentheses if their name, otherwise, would not appear in the standard reference.

Blake-Gonzalez, Cebula, and Koch (*Applied Economics*, 2020)

Betz and Jones (*American Journal of Agricultural Economics*, 2018)

Kolak et al. (*International Journal of Drug Policy*, 2020)

McLuckie et al. (Marynia Kolak) (*International Journal of Environmental Research and Public Health*, 2019)

Meadowcroft and Whitacre (*Substance Abuse*, 2019)

Meadowcroft and Whitacre (*Substance Abuse: Research and Treatment*, 2020)

Meadowcroft and Whitacre (*Substance Use & Misuse*, 2020)

Monnat et al. (David Peters) (*American Journal of Public Health*, 2019)

Parker et al. (Scott Loveridge) (*Journal of Affective Disorders*, 2017)

Table 1: Drug-Crisis-Related Presentations at Regional Science Meetings in North America

(Italicized listings were part of a special session on the drug crisis)

56th Meeting of The SRSA, April 2017
Elham Erfanian, West Virginia University (University of Kentucky)
Frank O'Connor, Eastern Kentucky University
64th Annual North American Meetings of the RSAI, November 2017
Elham Erfanian, West Virginia University (University of Kentucky)
David McGranahan, USDA – Economic Research Service
57th Meeting of The SRSA, March 2018
Paul Speaker, West Virginia University
Elizabeth Dobis, The Pennsylvania State University (USDA – Economic Research Service)
Scott Loveridge, Michigan State University
Elham Erfanian, West Virginia University (University of Kentucky)
Mark Mather, Population Reference Bureau
Frank O'Connor, Eastern Kentucky University
Michael Betz, The Ohio State University
65th Annual North American Meetings of the RSAI, November 2018
David McGranahan, USDA – Economic Research Service
Julie Marshall, Appalachian Regional Commission (Medical University of South Carolina)
Mark Schweitzer, Federal Reserve Bank of Cleveland
Elham Erfanian, West Virginia University (University of Kentucky)
Michael Betz, The Ohio State University
Devon Meadowcroft, Oklahoma State University (Mississippi State University)
Samia Islam, Boise State University
58th Annual Meeting of the WRSA, February 2019
Qiao Wu, University of Southern California
Michael Betz, The Ohio State University
Richard Gearhart, California State University – Bakersfield
58th Meeting of The SRSA, April 2019
Samia Islam, Boise State University
David McGranahan, USDA – Economic Research Service
Michael Betz, The Ohio State University
Mike Shepard, The Ohio State University
Collin Hodges, West Virginia University (University of Central Arkansas)
David Peters, Iowa State University
Brian Cushing, West Virginia University and Juan Tomas Sayago Gomez, Icesi University
Devon Meadowcroft, Oklahoma State University (Mississippi State University
Shishir Shakya, West Virginia University (Shippensburg University)
Elham Erfanian, West Virginia University (University of Kentucky)
66th Annual North American Meetings of the RSAI, November 2019
Isabel Ferraz Musse, University of Illinois
Devon Meadowcroft, Oklahoma State University (Mississippi State University)
Marynia Kolak, University of Chicago
Elham Erfanian, West Virginia University (University of Kentucky)
Mallory Avery (University of Pittsburgh)
Collin Hodges, West Virginia University (University of Central Arkansas)
David Peters, Iowa State University
Juan Tomas Sayago Gomez, Icesi University
Barbara Blake, Old Dominion University
Rodney Hughes, West Virginia University
Mark Schweitzer, Federal Reserve Bank of Cleveland
Shishir Shakya, West Virginia University (Shippensburg University)
59th Meeting of The SRSA, April 2020 – canceled due to COVID-19
Devon Meadowcroft, Oklahoma State University (Mississippi State University)
Brian J. Osoba, Central Connecticut State University
Juan Tomas Sayago Gomez, Icesi University
Elham Erfanian, West Virginia University (University of Kentucky)
David Peters, Iowa State University

Peters (*Journal of Rural Health*, 2019)

Peters (*Rural Sociology*, 2019)

Peters (*Rural Sociology*, 2020)

Ropero-Miller and Speaker (*Forensic Science International: Synergy*, 2019)

Shupp et al. (Loveridge) (*BMC Health*, 2020)

Speaker (*Forensic Science International: Synergy*, 2019)

This is an impressive group of papers, from a diverse group of scholars, in a short period of time. With the growing list of regional science scholars doing research on different aspects of the opioid crisis, we expect this list to continue its rapid growth.

3.4. Working Papers

As expected, given the extensive listing of conference presentations from a growing group of scholars, a large number of research papers related to the drug crisis are in progress, at various stages of completion. We are aware of many that are currently under review at scholarly journals. This bodes well for future contributions to the literature and policy discussions. The number of manuscripts in progress is too lengthy to list in this paper. Therefore, we will only include the more advanced papers (at the stage of journal submission) in the literature review that follows.

4. REVIEW OF RECENT LITERATURE

4.1. What Have We Learned from this Regional Science Research?

Despite the recent vintage of most drug crisis-related research in the discipline, regional scientists have covered a wide array of topics.[4] The largest single grouping of research has aimed to explain the causes of the crisis and why and how it varies across states or regions, as well as among places within a state or region. However, studies have also focused on the economic and social costs of the crisis, and on a variety of policies to reduce the magnitude of negative outcomes from the crisis. Among these studies, several emphasized new analytical methods or techniques to provide a more accurate and complete assessment of the crisis and responses to it.

Research by two Princeton economists, Anne Case and Angus Deaton, played a major role in raising much broader awareness of a crisis that had been quietly devastating large swathes of mostly rural America since the late 1990s, earlier in some places. The catalyst and foundation for much research on the drug crisis is their work leading to the "deaths of despair" explanation for the crisis – suicide, opioid overdoses, and alcohol-related illnesses resulting from a breakdown of working-class life for the less-educated, with all of the financial, social, and health issues that follow (Case and Deaton, 2015, 2017).[5]

Though it is not easy to precisely quantify "deaths of despair," many have attempted to test this hypothesis against competing explanations for the drug crisis. O'Connor (2016) studied mortality in the eight regions of Kentucky for the 1999-2003 and 2010-2014 peri-

[4]We limit our review to "regional science/spatial" research. There are excellent reviews articles with broader coverage, such as Maclean et al. (2020) and, for research on naloxone, Smart et al. (2020).

[5]Most recently in their book, Case and Deaton (2020).

ods. He concluded that much of the variation in mortality rates across regions (higher and increased more rapidly in the three eastern, rural counties) could be explained by factors such as median income, education, poverty, and income inequality. Goetz and Davlasheridze (2018) estimated a fixed effects county level panel data model to relate socioeconomic variables to opioid-related drug overdoses. They found that rurality, as measured by lower population density and reductions in net farm income, were associated with higher overdose rates. Blake-Gonzalez et al. (2020) used panel data describing 84 Virginia cities and counties to assess the validity of the "deaths of despair" hypothesis and alternate explanations that focus on other socioeconomic conditions. They found deaths of despair to be only a partial explanation for the upsurge in drug-overdose deaths and concluded that a much broader view of the causes of drug-overdose deaths is merited. Hodges and Stephens (2020) conducted a panel study using a unique dataset which included confidential individual-level death certificate data from West Virginia, with access to individual and local characteristics. Individual employment in certain industries (coal mining, construction, and restaurant and food services), or lack of employment, was associated with a higher risk of opioid overdose death. They also observed significant spatial spillovers of employment effects. While results from all of these studies are consistent with a "deaths of despair" effect, differences in data sets, methods, models, and measurement of "deaths of despair" make it difficult to draw general conclusions. This is especially true for the three studies that just focused on a single state. While each helps to advance understanding, it is important to know whether the models and results are generalizable to other states. As a whole, the studies could take better advantage of spatial clustering of characteristics and outcomes to enhance understanding. Interest in "deaths of despair" may move to a higher level in the aftermath of the 2020 chaos from the coronavirus and the political/electoral system.

Consistent with Case and Deaton's (2015, 2017) discussion of a longer-term breakdown of working-class life, a number of studies focused more precisely on a location's general economic conditions and their trends over time. Carpenter et al. (2017) found mixed evidence on the cyclicality of illicit drug use, but robust evidence that economic downturns lead to increases in the intensity of prescription pain reliever use as well as increases in clinically relevant substance use disorders involving opioids. Aliprantis et al. (2019) used a panel study to examine the relationship between labor market participation/conditions and opioid abuse across both rural and metropolitan areas of the U.S. from 2007 to 2016. They concluded that opioid availability decreases labor force participation, while a large labor market shock does not influence the share of opioid abusers. It would be interesting to see the impact of the current COVID-19 epidemic and how its corresponding changes in the labor market has influenced the share of opioid abusers. Musse (2020) posited that better employment conditions could affect opioid use through two channels: increasing physical pain from working or reducing mental distress that can, otherwise, contribute to substance abuse. She used a large dataset of opioid and over the counter (OTC) painkiller sales to measure the effect of employment shocks on demand for pain medication. She found that an increase in the employment-to-population ratio decreases the per-capita demand for opioids, while it increases the per-capita demand for OTC painkillers. She also decomposed demand for opioids into the two channels, which helped to confirm her conclusions that economic expansion decreases demand for opioids for mental health reasons, but increases demand for pain

medication (OTC and some opioid), with the latter connected to industries with high injury rates. All of these studies would benefit from a better accounting of spatial heterogeneity, spatial clustering, and spatial spillovers.

While the above research helps to understand how we got to this point, other research has attempted to shed more light on how to respond to the crisis. Policymakers have enacted a variety of programs during the past few decades to fight addiction. Among the first, and now among the most widespread, has been the Prescription Drug Monitoring Program (PDMP). A PDMP is an electronic database that tracks controlled substance prescriptions in a state. Meadowcroft and Whitacre (2019) examined the effectiveness of PDMPs on prescription drug and heroin overdose deaths for the 1999-2014 period. Their results showed that implementation of a PDMP increased both prescription and heroin deaths in states. In addition, they examined the effects of mandatory access (to the PDMP) requirements for prescribers. Their results indicated that adding a mandatory access constraint for prescribers was correlated with increased heroin-related deaths – consistent with the concern that tighter controls on the supply of prescription opioids could push addicts toward inexpensive, readily available heroin. Gihleb et al. (2020) analyzed the relationship between PDMPs and neonatal abstinence syndrome (NAS) incidents. Using data from State Inpatient Databases (SID), the authors found that adoption of a PDMP law reduced the incidence of NAS in the U.S. Shakya (2020b) examined the impact of PDMPs on state-level mortality from prescription opioids for 1999-2017. He found evidence of the effectiveness of "must-access" PDMP laws in reducing prescription opioid overdose death rates relative to voluntary PDMP states. While these laws were ineffective in reducing overall prescription opioid overdose deaths, "must-access" PDMPs did have the intended effect in some states. He concluded that the effects of PDMPs are confounded by other factors such as marijuana and naloxone access laws, poverty level, income, and education. He also noted the difficulty of sorting out mortality from prescription drugs due to the difficulty of distinguishing prescription fentanyl from illicit fentanyl when determining cause of death. Undoubtedly, this has confounded conclusions in many studies. Shakya (2020a) focused on how PDMPs affect the quantity or rate of prescribing opioids. He concluded that, on average, "must-access" PDMPs reduced retail opioid prescriptions dispensed, by about seven per 100 persons per year in each county. After incorporating border county effects, however, he determined that, on average, the "must-access" benefit is sliced by more than 50 percent to three per 100 persons if bordering counties do not have a "must-access" law in place. Much work is still needed on this topic given the potential for PDMPs to significantly reduce use of and mortality from prescription drugs. Mandatory PDMP is a recent addition to several states' PDMP policies. Almost every study takes a somewhat different approach to measuring or quantifying this potentially important provision – leading to a wide array of results and conclusions. Using a more common and consistent set of measures for PDMP programs would help immensely. In addition, this line of research would benefit from a better accounting for spatial spillovers, which have the potential to be significant for this policy issue. It is problematic if individuals can avoid strict prescription drug monitoring and controls simply be crossing a nearby state border. These are the two biggest challenges for this branch of opioid research.

A second approach to trying to reduce addiction by limiting access to legal prescription drugs is establishing prescribing limits, such as only permitting an initial seven-day supply

of an opioid painkiller. Avery and Bradford (2020) posited that, while PDMP programs might be effective at reducing access to drugs for those already abusing prescription opioids, prescribing limits might be more effective at preventing addiction from prescription drugs in the first place, which would lead to fewer overdoses overall. Her analysis found that, on average, enacting prescribing limits led to significantly fewer overdoses from semisynthetic opioids (Oxycodone and Hydrocodone), as well as from heroin, and possibly from fentanyl.

Naloxone is a drug that can immediately reverse the effect of an opioid overdose, and, thus, has the potential to prevent many opioid overdose deaths if it can be administered quickly enough. Most states have passed laws related to use of Naloxone. An important question related to Naloxone is whether, ultimately, it decreases drug overdose mortality (by directly preventing deaths) or increases mortality through moral hazard - encourages riskier behavior. Erfanian et al. (2019) address this question using a state-level spatial difference-in-difference model. The spatial analysis allowed the authors to consider not only the direct impact on the state that enacted a particular law, but also the indirect effect on overdose mortality in neighboring states. Introducing the spillover effect to opioid-related policy impact analysis is quite new. They found no evidence of significant direct effects, regardless of the types of provisions, but, in almost all cases, found positive indirect effects – implementation of Naloxone provisions in a state leads to increasing opioid mortality in surrounding states. Building upon this research there is a potential avenue for introducing more advanced spatial modeling to analyze the opioid-related policy analysis.

Many, perhaps most, people would reflexively reject the notion of locating a Substance Abuse Treatment (SAT) facility in the vicinity of their home or business – a NIMBY response. Though considering it from very different perspectives, Bondurant et al. (2018) and Meadowcroft and Whitacre (2020a) both focused on whether presence/number of treatment facilities had a beneficial effect on a region. Bondurant et al. (2018) examined the impacts of expanding access to SAT facilities on local crime in counties with at least one treatment facility, from 1999 to 2012. Their analysis determined that presence of a SAT facility reduced a wide variety of crimes. Using the South census region, Meadowcroft and Whitacre (2020a) examined whether presence of an Opioid Treatment Program (OTP) was associated with lower opioid-related death rates during 2014–2016. For their study, the presence of an OTP mostly had no statistically significant effect on the rate of (or change in) future opioid deaths, in either rural or urban counties. Proximity to a neighboring county OTP displayed a similar lack of association. They believe that additional work is needed on this topic. The need for spatial analysis of the treatment and recovery facilities and their characters at a national level is inevitable.

Parker et al. (2017) undertook a practical study focused on finding a method to overcome the significant time delays that prevented researchers from working with the most current mortality data. Applying Google Trends search data, they forecasted 2015 state alcohol-induced death (AICD) drug-induced death (DICD), and suicides rates. The authors estimated two different models with the same dependent variable (death rate). The first model used Google Trends data to forecast mortality. The alternative model used more traditional factors, such as unemployment rate and real disposable personal income per capita rate. The authors concluded that the research demonstrates the viability of using Google trend big data to predict mortality rates for drug, alcohol, suicide, and other behavioral

health-related causes of death. With more recent data now available and the rapidly changing dynamic of the opioid crisis, it would be useful to know how well their Google Trend method would have estimated the increase in 2018 and 2019 opioid-related deaths. More importantly, given the substantial intrastate variation in drug overdose mortality, can their method be used to reasonably estimate substate mortality? Given the substantial delay in processing and producing mortality data, this idea has potential for providing helpful early signals if it can reasonably handle these types of challenges.

One of the great strengths and contributions of the regional science discipline is spatial analysis. In its most basic form, this amounts to using subnational jurisdictions such as regions, states, counties, or even zip code areas as the basis for analysis. Considering spatial correlations and spatial dynamics, however, opens up a whole new set of tools and possibilities for spatial analysis. Shakya (2020a) (discussed above), using a straightforward methodology, shed some light on the importance of spatial analysis that accounts for correlations and clustering over space – mandatory-access PDMPs had a diminished effect if neighboring locations were not also constrained by a mandatory-access PDMP. Erfanian et al. (2019) took spatial analysis to a much higher level, employing a spatial difference-in-difference model to account for spatial correlation and provide estimated direct and indirect effects for each explanatory variable. McLuckie et al. (2019) and Kolak et al. (2020) illustrate the vast potential for advanced spatial methods to greatly increase knowledge regarding important issues and to help design more nuanced policy responses.

McLuckie et al. (2019) investigated the syndemic of opioid-use disorder (OUD) and the associated increase in overdoses and risk of hepatitis C virus (HCV) and human immunodeficiency virus (HIV) transmission for rural counties in southern Illinois. Especially given the relative isolation in rural areas, often accompanied by a dearth of health services, local health departments (LHDs) can play an important role. They surveyed rural Illinois LHDs to document OUD-related services, calculated county-level opioid overdose, HIV, and hepatitis C diagnosis rates, and then developed bivariate choropleth maps to display LHD service provision relative to disease burden for each county. The bivariate mapping showed rural counties with limited OUD treatment and HIV services and with corresponding higher outcome/disease rates to be dispersed throughout Illinois. The information from the bivariate mapping should allow more precise geographic targeting of resources to address the opioid crisis and related infectious disease by identifying areas with low LHD services relative to high disease burden.

Unfortunately, lack of access to crucial data limits the vast potential of these methods. McLuckie et al. (2019) rely on data from the County Business Patterns series produced by the U.S. Bureau of the Census. These data provide information on the number of firms, firm size and/or number of employees, and payrolls, often with disclosure issues. This series is not designed to provide important details, such as types or treatment offered, types of clients, financial accessibility (who can afford treatment), etc. Inexpensive short-term outpatient drug treatment programs that may do no more than provide necessary testing and medication are very different from a facility that provides long-term inpatient treatment using the latest methods, with on-site counseling, and other types of support. Cushing and Erfanian (2020) discuss the vast amount of detailed information that is collected for virtually every treatment and recovery facility in the country. The National Survey of Substance Abuse Treatment

Services (N-SSATS) is conducted every year under the direction of the Substance Abuse and Mental Health Services Administration (SAMHSA), an agency within the U.S. Department of Health and Human Services. An almost complete microdata (at the facility level) database is readily available, but, for confidentiality reasons, location information is provided only down to the state of location.[6] A limited amount of information is provided at a substate level, but it is too incomplete to be useful for analysis.[7] It would be well worth the effort for researchers, institutions, or policymakers to work with SAMHSA on developing a protocol to provide restricted access to the complete survey data in order to evaluate adequacy and effectiveness of treatment and recovery facilities at a local level.

Kolak et al. (2020) adapted a risk environment framework to characterize rural southern Illinois and describe the relations of risk environments, opioid-related overdose, HIV, Hepatitis C, and sexually transmitted infection rates between 2015 and 2017. They implemented an Exploratory Spatial Data Analysis to characterize data attributes, temporal, and spatial dimensions of the rural risk environment and opiate-related health outcomes. Association of data attributes and spatial relationships were examined using correlation tests, choropleth mapping, and hot spot analyses (i.e., local spatial autocorrelation test). They then used a "regional typology analysis" to generate data-driven risk regions and compare health outcomes. From this, they were able to identify pervasive risk hotspots that were in more populated locales with higher rates of overdose and HCV incidence, as well as emerging risk areas that were in more rural locales that had experienced an increase in analgesic opiate overdoses and generally lacked harm-reduction resources. They concluded that rural risk environment vulnerabilities and associated opioid-related health outcomes were multifaceted and spatially heterogeneous and called for additional work to better understand how refining geographies to more precisely define risk can support intervention efforts and further enrich investigations of the opioid epidemic. The work of McLuckie et al. (2019) and Kolak et al. (2020) and the wealth of policy-relevant information garnered from the studies would not have been possible without the relatively recent advances in computer technology and capacity. The policy applications are limitless.

Measurement and interpretation of drug-overdose mortality rates, the dependent variable in most of these studies, may be the biggest concern in this literature. The International Classification of Diseases (ICD) codes, used as the basis for the mortality data, are not sufficiently granular to clearly identify precise drug information related to cause of death. First, CDC mortality data usually list multiple contributing causes of death for an individual, with no way to distinguish between the primary and secondary causes of death. Most often, multiple drug codes are listed in the case of drug-overdose deaths. Second, ICD codes do not have distinct codes for some drugs. For example, fentanyl, widely accepted as the major cause of the recent surge in drug-overdose mortality, is included, along with some other opioids such as tramadol, in the T40.4 – "Poisoning by, adverse effect of and underdosing of other synthetic narcotics" classification. In addition, the T40.4 classification is considered as a "prescription opioid" group. While fentanyl is a prescription drug, it is tightly controlled, and not widely used – thus, not a major source of abuse. Almost all fentanyl detected

[6]See the Public Use files at https://wwwdasis.samhsa.gov/dasis2/nssats.htm. Also see https://www.datafiles.samhsa.gov/study-series/national-survey-substance-abuse-treatment-services-n-ssats-nid13519.
[7]See the Directories at https://wwwdasis.samhsa.gov/dasis2/nssats.htm.

in drug-overdose deaths is illicit fentanyl, mostly produced outside of the U.S. Third, a number of studies have concluded that many deaths from specific opioids, such as heroin or fentanyl, get classified as T40.6 – "Poisoning by, adverse effect of and underdosing of other and unspecified narcotics" and that many overdose deaths from specific opioid or nonopioid drugs get classified as T50.9 – "Poisoning by, adverse effect of and underdosing of other and unspecified drugs, medicaments and biological substances" (see Boslett et al. (2020)). Ruhm (2018) estimated that heroin/synthetic opioid-involved deaths were undercounted by 20-35 percent annually between 1999 and 2015. It is imperative that researchers understand the limitations of the data and, armed with this knowledge, appropriately analyze the data and interpret the results.

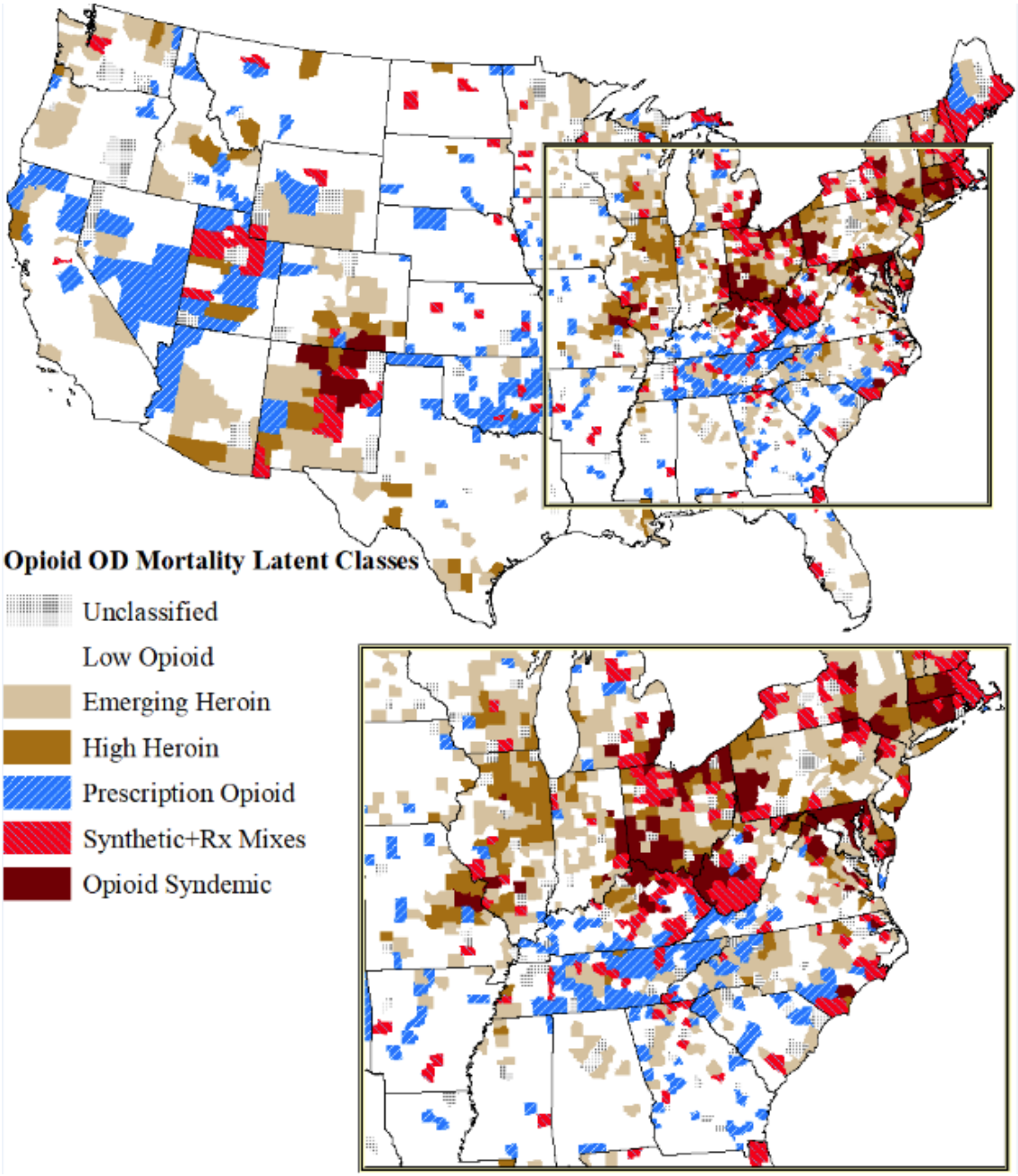
4.2. Other Regional Science Perspectives

Regional scientists, especially rural sociologists and public health social scientists, have documented a rural mortality penalty (Jensen et al., 2020). Beginning in the 1980s, rural communities experienced the twin forces of worsening health mortality and worsening socioeconomic conditions, likely driving the health gap between urban and rural areas. The former is manifest as sharp gains in drug mortality, in particular opioid-related, along with persistently high mortality from other major diseases. The latter as depopulation and job loss that curtails rural health and social services specifically, and quality of life generally (Peters, 2019). Regional science plays an important role in understanding the socioeconomic aspects of the opioid crisis and is in the forefront in understanding impacts of the COVID-19 pandemic.

Like regional scientists in other disciplines, sociologists have extensively examined the geography of the U.S. opioid overdose crisis. Large swathes of the upper Midwest and Great Plains have some of the lowest rates of fatal overdoses. At the same time, Appalachia and parts of the Ohio River valley post some of the highest fatality rates in the nation and have for some time (Monnat, 2018; Ruhm, 2017). Extending this work, Peters et al. (2020) identified county clusters based on the mix of opioid mortality (see Figure 7). They found there is no single opioid epidemic. Rather, they found there are multiple and overlapping ones, including places with three coinciding epidemics, what they term an opioid syndemic. Regional scientists are increasingly looking at how the drug problem is situating not only in geographic space, but also in socioeconomic space.

Beyond geography, regional scientists have identified compositional risk factors contributing to higher overdose rates, which include high poverty, unemployment, disability, single parent families, divorce, and lower educational attainment (Monnat et al., 2019; Ruhm, 2019; Zoorob, 2019). This work also found that larger shares of certain vulnerable demographic groups have higher overdose rates, such as the elderly, military veterans, and Native Americans (Kerr et al., 2017; Monnat, 2019). Extant research identifies several contextual factors that influence drug mortality, including social norms, neighborhood disadvantage, social capital, the physical environment, availability of health and social resources, and policy and regulation (Galea et al., 2003; Dasgupta et al., 2018). Monnat (2019) found that fatal drug overdose rates among non-Hispanic whites is linked to opioid over-prescribing, fentanyl exposure, economic distress, reliance on mining and service sector employment, and persis-

Figure 7: Opioid Overdose Mortality Latent Classes in 2002-2004, 2008-2010, and 2014-2016



Notes: for n=3,079 counties in the conterminous U.S. Unclassified counties have posterior class probabilities below Pr<0.7.

tent population loss. Peters et al. (2020) found that counties affected by any opioid epidemic tends to be older, less ethnoracially diverse, and have a declining industrial base. Specifically, prescription and synthetic-prescription mixture epidemics tend to occur in smaller and more remote counties, dominated by mining employment.

More broadly, regional science has established a strong linkage between economic conditions and self-harm mortality (Kaplan et al., 2015; Ruhm, 2015, 2018, 2019). Work by Hollingsworth et al. (2017) found a countercyclical trend between poor economic performance and higher mortality rates from alcohol and drug-related causes. In short, substance abuse increases when the economy slumps. The relationship between drug overdoses and unemployment is especially strong and long lasting at the county level (Ruhm, 2019). Betz and Jones (2018) found that both job and wage declines in lower skilled industries increased opioid-related deaths, especially for rural white men in goods-producing sectors, but also for African Americans and women who work in the services sector. Further, the authors found that wage growth is an important protective factor, which suggests job quality (e.g., higher wages) matters as much as job quantity.

Sociologists engaged in regional science work have described drug mortality as the "deaths of despair" thesis, suggesting it is linked to economic dislocation, social isolation, and place-level downward mobility, particularly among working-class non-Hispanic white people (Case and Deaton, 2017). Although not fully tested empirically, this contention is well justified: the past two decades the increase in opioid-related mortality has corresponded with significant economic stressors in some parts of rural America, including de-industrialization, job loss, and wage stagnation (Monnat et al., 2019; Monnat, 2020; Peters et al., 2020). Accordingly, high rates of opioid-related mortality may reflect collective stress, anxiety, and hopelessness that are symptomatic of place-level economic precarity, downward mobility, and social isolation.

However, economic distress, industrial composition, and demographic decline alone are insufficient to account for the rise in opioid mortality and other health problems. Regional scientists in sociology view social disorganization as a key linkage between economic disadvantage and poor health outcomes. The collective efficacy model of disorganization theory argues that economic distress atrophies social and cultural systems, and this is what actually causes social problems (Bruinsma et al., 2013). Social atrophy can take the form of diminished bonding social capital, poor social networks, low attachment to place, reduced civic participation, lack of shared norms, and loss of collective identity. This hinders the ability of communities to respond to economic decline, potentially leading to a number of social problems like drug abuse (Wikström and Sampson, 2006). Current research in regional science is beginning to more fully explore the role of social infrastructure, in addition to the more traditional economic and physical infrastructures.

For example, community social support has been found to have a small yet significant impact on reducing opioid mortality in nonmetro counties. Studies by Monnat et al. (2019) and Peters et al. (2020) found that larger numbers of social capital producing establishments results in lower prescription opioid mortality in nonmetro counties. However, their work shows no effect on heroin or synthetic opioid mortality; and no effect in metro areas. Further, measures of civic participation were not associated with opioid mortality. Meadowcroft and Whitacre (2020b) and Shupp et al. (2020) both focused on the need and benefits of community engagement in dealing with the opioid crisis. The starting point for Shupp et al. (2020) is that prescription drug abuse (PDA) is a major entry way into long-term opioid abuse and use of illicit drugs. Failure to recognize the signs of PDA (one's own PDA or a loved one's PDA) and stigma associated with acknowledging PDA (own or loved one's) prevent

crucial early intervention. From a nationwide survey questionnaire, the authors determined that those with some life experience of PDA were less likely than others to recognize PDA in another person and more likely to attach stigma to having or knowing someone with PDA. Both of these outcomes were more likely for males and for younger people. They concluded that public outreach and education about PDA, perhaps through the mental health system, would be a fruitful approach for reducing opioid abuse. The study by Meadowcroft and Whitacre (2020b) implemented a series of meetings in one rural community struggling with the opioid crisis. In the meetings, they engaged local residents who dealt with the crisis as part of their jobs. The ultimate goal was for the participants to develop a consensus about the best way to allocate treatment/recovery resources in the future to best meet the needs of the local community. Through this community engagement, they observed changes in opinion and a move toward more consensus regarding priorities for their local area.

Regional scientists and sociologists are also beginning to move beyond statistical analyses of mortality data, employing mixed methods approaches to the opioid crisis. In a conference paper to NARSC by Peters (2019), the authors created a typology of opioid resiliency and vulnerability by comparing predicted and observed mortality rates for nonmetro counties using a Poisson model. The team then conducting interviews in these communities to better understand why some places did better-than or worse-than predicted. For example, resilient counties had low opioid mortality despite all the risk factors. Interviews found better local regulation of prescribing and dispensing, mostly informally. There was a large minority community, but it was long-established and integrated into the community. Social and health services were unified within the county and there were extensive collaborations among neighboring counties. There was a respect for authority and the community was kept up with little signs of neglect. Further, meth was the major drug issue in these communities, supplanting opioids, yet deaths were rare. By contrast, vulnerable places were predicted to have low opioid mortality, yet rates were very high. These were very rural and remote places where a transient minority population segregated from the rest of the community. Local health services were small, under-staffed and under-funded, and not well coordinated. From interviews it appears there is a sizable amount of prescription opioid diversion due to lax oversight; and a steady supply of illicit heroin trafficked by migrant agricultural workers. The heartening insights came from coping counties, or those that did better than predicted yet still had high mortality rates. Coping places exemplified the disability-dispensing-death pathway and the deaths of despair narrative. Despite these structural challenges, coping places came to accept opioid abusers rather than stigmatize them. So many families had been affected that it was no longer possible to see drug users as "others." As a result, there was a concerted effort from health, social services, and law enforcement to provide expanded mental health services. Local organizations became active in providing services and fundraising to support these efforts. Simply put, opioids began to be seen as a collective problem, not an individual one. This highlights some of the important insights that can be gained using mixed method approaches.

More recently, the COVID-19 pandemic has accentuated the need for regional scientists in order to better understand this new and rapidly evolving public health crisis. In a recent paper, Peters (2020) created a COVID-19 susceptibility scale at the county-level to measure not only the potential for outbreaks, but also to assess local resiliencies and vulnerabilities

for use in public health planning. He found that susceptible rural and semi-rural counties are most vulnerable due to poor healthcare infrastructure, lower health insurance coverage, lack of broadband internet access that hinders telemedicine and telecommuting, and weaker social capital as evidenced by low rates of charitable giving and fewer civic organizations. This limits the ability of these communities to respond immediately to the pandemic using local resources, forcing them to wait for state or federal assistance. In another study by Cheng et al. (2020), COVID-19 mortality is found to be highest in rural counties with the highest percentage of African American and Hispanic populations. The authors conclude there is a sizable race penalty for COVID mortality across the rural-urban continuum but is most pronounced in rural counties. All of this underscores the need for additional regional analysis of the causes and consequences of the pandemic.

5. CONCLUSION: THE PATH FORWARD

By fall 2016, a mostly regional drug issue that had flown under the radar exploded into a serious national drug crisis. It was exacting high social, economic, physical, and psychological costs on many states and, especially, on many localities. The cost in lost lives was severe, as drug-overdose mortality trended sharply higher. Despite some successes, such as turning the tide on prescription drug abuse, and a flicker of hope when overdose mortality declined in 2018, drug abuse and mortality continues to surge and to reach crisis levels in more places. As it does, the already stunning costs continue to increase, devastating more lives and more locales.

Despite the highly regional/spatial nature of the growing drug epidemic and its costs and consequences, it appeared to be no more than a blip on the radar of the regional science community as of 2016. Nothing had been published in any regional science journals, nor presented at regional science conferences, with just one or two working papers evident. To be fair, relatively few social scientists were tuned into the drug crisis before 2015.

As our review demonstrated, the regional science community has become significantly more engaged in studying the drug crisis since 2016. Many scholars have presented papers at regional science conferences, including several special sessions, some papers have been published in regional science journals, and a much larger number of regional science papers have been published in other academic journals, including many journals focused on addiction. Regional science research has helped inform about the causes and consequences of the drug crisis, developed or evaluated policies, and helped public health officials better understand the situation on the ground, as well as the dynamics of the drug crisis in their particular region. Regional science still has much more to contribute along these same lines, so we hope this kind of work will continue to grow.

Going forward, what are some additional opportunities for regional science to contribute regarding the drug crisis or similar types of issues? First, one of the major advantages of regional science is the ability to integrate concepts from many disciplines. Traditionally, economics, geography, agricultural/resource economics, and planning have served as the core disciplines of regional science. This naturally has led the field to focus on how economic and physical infrastructure affect outcomes (in this case, health outcomes) within a spatial framework. In general, regional science would do well to purposefully widen its tent to

incorporate related disciplines, particularly sociology, which has much in common and much to contribute, especially on a topic such as the drug crisis. It would also be wise to increase collaboration with public health experts, who have much better understanding of many aspects of the drug crisis and parts of the data, but, in turn, could greatly benefit from our expertise in spatial, regional, and economic analysis. More broadly, regional science is well positioned to understand future health crises, such as pandemics, because of our ability to think about problems through multiple disciplinary lenses.

Second, regional science should also consider how community agency, in addition to community structure, may account for differences in drug mortality. Most socioeconomic and spatial factors are fixed or generally beyond local control in the near-term. Understanding how communities have effectively responded to a health crisis, given their structural conditions, is critical since such strategies are amenable to local action and within the community's control. Examining why certain places did better than predicted not only informs model specification, but also provides valuable information for policy makers and local communities to address pressing health crises. Regional science can take a leading role in "mixed method" social science, using quantitative spatial analysis to identify communities where more in depth qualitative methods can be used, allowing for a better understanding of the causes, consequences, and responses to the drug crisis that cannot be obtained from secondary data.

Third, regional science needs to orient our work to address more "pulse" events that happen suddenly and with little advance warning. Traditionally, the regional science disciplines have focused on longer term "press" events that better align with theory, data collection, and academic culture. However, societal challenges over the coming decades will increasingly be in the form of short-term "pulse" events, such as natural disasters from climate change or fast spreading pandemics from globalized socioeconomic systems. The COVID-19 pandemic highlights the need for the type of data-driven and localized information provided by regional scientists. For example, knowing local impacts, responses, and resiliency to COVID-19 allows state and national public health officials to plan and allocate resources accordingly, both for the current pandemic and future ones. Having rapid access to information about a crisis and being prepared to rapidly respond to "pulse" events is likely much more important for rural areas. Rural places are limited in their ability to respond to major crises due to their small size, isolation, and relative lack of economic diversity and institutional capacity. In other words, rural areas are less able to recover from short-term "pulse" events, which may precipitate long-term problems.

Fourth, regional science should not only examine what is happening across the rural-urban continuum, as is tradition, but to also look at what is happening within rural and urban areas. Rural communities are heterogeneous and numerous. Broad statements about "rural" effects may result not only in ecological fallacies but may also mask unique cases that can inform research and practice. For example, some rural communities are ethnoracially diverse and some are not. Others are sparsely populated and declining, but some are fast growing due to exurbanization or natural amenities. Regional science needs to focus on the diversity of places within rural America to better inform health research, policy, and practice for these specific types of rural communities.

Fifth, though it should go without saying, we should remember we are "regional scientists." Regional science is all about accounting for space (spatial analysis) and how space

affects processes and outcomes. Regional scientists account for space in many ways: conduct analysis at the proper geographic level, consider urban agglomeration effects, look at spatial size of markets, model the economic development constraints and the social, economic, and health costs imposed by spatial isolation (such as in some of the mountainous areas of Central Appalachia), map out the distribution of characteristics over space, or account for spatial spillovers through border effects or more advanced spatial modeling. We have a toolbox filled with tools that range from the simple, such as border dummies, to the complex, such as GIS or spatial statistics and econometrics. Spatial analysis gives regional science a unique perspective that is richer in detail that often leads to new insights.

Finally, we argue the above recommendations ought to be addressed through a new organizational structure that would coordinate regional science work on public health issues. We are thinking of something beyond relying on one or a few scholars willing to coordinate sessions at one or two regional science conferences each year and counting on those who are interested to always be willing to attend those specific conferences during the year. It would be advantageous to have an organized forum to help the discussions become ongoing and make it easier for other scholars, policy makers, or other officials or administrators to find us and communicate with us. This could facilitate sharing new ideas, learning about new data, connecting with new scholars across disciplines, engaging with public officials, and collaborating on grant proposals to advance our work. The goal is to better coordinate regional science work on public health issues for a more rapid and coordinated response from our research community. One model worth considering is USDA's multistate research and extension projects. Under this model, regional science organizations could facilitate and provide startup funds for this effort. As there are many possible options, we consider our call as a starting point for future discussions on how regional science can establish a national presence in public health research and policy across spatial scales.

The U.S. drug crisis is still accelerating and is unlikely to go away any time soon. It will continue to wreak havoc on people and places. We hope that the regional science community will build on its current research and make a commitment to continue contributing our expertise and insights in the search for better understanding and better policy tools. We have much to add to the discussion.

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