International Journal of Drug Policy 57 (2018) 119–129

Contents lists available at ScienceDirect

International Journal of Drug Policy

journal homepage: www.elsevier.com/locate/drugpo

Commentary

Opioid-related mortality in rural America: Geographic heterogeneity and intervention strategies

Khary K. Rigg[a,*], Shannon M. Monnat[b], Melody N. Chavez[c]

[a] Department of Mental Health Law & Policy, Louis de la Parte Florida Mental Health Institute, College of Behavioral & Community Sciences, University of South Florida, 13301 Bruce B. Downs Blvd., Tampa, FL, 33612, United States

[b] Department of Sociology, Lerner Center for Public Health Promotion, Maxwell School of Citizenship and Public Affairs, 426 Eggers Hall, Syracuse, NY, 13244, United States

[c] Department of Community & Family Health, College of Public Health, University of South Florida, 13201 Bruce B. Downs Blvd., Tampa, FL, 33612, United States

ARTICLE INFO

Keywords:
Opioid use disorders
Opioid-related mortality
Heroin
Rural
Urban
Prevention
Treatment
Harm reduction
Fentanyl

ABSTRACT

Over the last two decades, opioid-related mortality rates have increased dramatically to become a serious public health concern in the United States. Opioid-related mortality has reached epidemic levels in certain rural areas of the U.S., such as Appalachia, New England, and the Mountain West, while remaining relatively low in others, such as the Delta South and Great Plains. Explanations for geographic variation in opioid mortality are unclear, contributing to ineffective policies and interventions. The goal of this article is to summarize the existing literature on the opioid epidemic in the rural U.S. to help guide intervention efforts. This paper 1) describes geographic heterogeneity in opioid-related mortality, with a focus on rural areas, 2) summarizes factors that likely contribute to this heterogeneity, and 3) discusses potential strategies for addressing the opioid epidemic in the hardest-hit rural communities. The information presented in this paper dispels the myth that the opioid epidemic is disproportionately rural, and demonstrates that the magnitude of the epidemic has varied considerably across different rural areas. This paper provides important insights for public health professionals, treatment practitioners, researchers, and policymakers as they work toward solutions that take into account the diversity of rural communities and the dynamic nature of the opioid epidemic.

Introduction

Over the last two decades, opioid[1]-related mortality rates have increased dramatically to become a major public health crisis in the United States (U.S.). In 2016 alone, opioids were involved in 45, 838 deaths, an increase of over 400% since 1999 (Centers for Disease Control and Prevention (CDC), 2017). Additionally, since 2005, the national rate of opioid-related inpatient hospital stays has increased by 64%, and the rate of opioid-related emergency department (ED) visits has increased by 99% (Weiss et al., 2017). A recent report by the White House Council of Economic Advisers estimated that the cost of the opioid crisis, including health care, criminal justice, lost productivity, and value of lives lost was $504 billion in 2015 (2.8% of GDP; White House Council of Economic Advisers, 2017).

Although it is technically true that "addiction does not discriminate," there is significant geographic variation in drug mortality rates across the U.S. (Monnat, 2018). Rates of opioid-related inpatient hospital stays, ED visits, and mortality are high in some predominantly rural[2] states like Maine, Kentucky, and West Virginia (Estep, 2016; Keyes, Cerda, Brady, Havens, & Galea, 2014), but rates are among the lowest in other largely rural states, including Iowa and Nebraska (Weiss et al., 2017). Compared to large urban centers, rural places have historically been overlooked by national politicians, media, and researchers, but the current opioid epidemic has prompted significant attention toward rural areas. Unfortunately, most national studies obscure the geographic diversity of the opioid epidemic. Recent media and political attention on rural areas provides a time-sensitive opportunity for researchers to inform place-based strategies for addressing the crisis.

Our objectives are to: 1) describe geographic heterogeneity in opioid-related mortality, with a focus on rural areas, 2) summarize factors that likely contribute to this heterogeneity, and 3) discuss potential strategies for mitigating the opioid epidemic in the hardest-hit rural areas. Throughout the paper, we give attention to both rural

* Corresponding author.
E-mail addresses: rigg@usf.edu (K.K. Rigg), smmonnat@maxwell.syr.edu (S.M. Monnat), mchavez4@health.usf.edu (M.N. Chavez).

[1] Throughout the paper we use the term opioids to include prescription opioid pain relievers, heroin, and synthetic opioids (e.g., fentanyl).

[2] Throughout the paper, we use the term "rural" to mean people and places that are outside metropolitan statistical areas.

https://doi.org/10.1016/j.drugpo.2018.04.011
Received 1 August 2017; Received in revised form 9 March 2018; Accepted 16 April 2018

versus urban and *within*-rural variation in opioid mortality, particularly as it relates to regional and racial/ethnic differences.

Geographic heterogeneity in opioid-related mortality

Studies are mixed on whether opioid use disorder (OUD) rates are higher in rural or urban areas, with some national studies finding higher rates in rural areas (Cicero, Surratt, Inciardi, & Munoz, 2007; Paulozzi & Xi, 2008), especially among certain vulnerable rural populations, including youth, American Indians, individuals with disabilities, and workers in manual labor occupations (Havens, Young, & Havens, 2011; Keyes et al., 2014; Monnat & Rigg, 2016; Rigg & Monnat, 2015b). Other studies find higher rates in urban areas or no significant difference (Lenardson, Gale, & Ziller, 2016; Rigg & Monnat, 2015a; Weiss et al., 2017). Inconsistencies in the literature on rural/urban differences in OUDs and mortality may be because national trends obscure important regional and between-state differences (Buchanich et al., 2016). Accordingly, in this section, we use data from the CDC and existing studies to describe geographic heterogeneity in opioid-related mortality (CDC, 2017). Full methodological details are described in Appendix A.

Fig. 1 shows opioid-related mortality rates by metropolitan status for the U.S. overall and disaggregated by U.S. Census region. As shown in Panel A, as of 2016, opioid-related mortality rates for the U.S. overall were highest in large fringe and medium metro counties and lowest in the most rural counties (i.e., noncore nonmetro). However, over the past two decades, mortality rates increased more in rural than in urban areas. Between 1999 and 2016 the age-adjusted opioid-related mortality rate increased by 158% in large central metro counties, 507% in large fringe metro counties, 388% in medium metro counties, 584% in small metro counties, 682% in micropolitan nonmetro counties, and 721% in noncore nonmetro counties. However, these aggregate trends obscure important regional differences. In the northeast (Panel B), since the late 2000s, rates have been higher outside of large central metro counties, with the largest increase since 1999 (over 1000%) occurring in micropolitan counties. Conversely, in the Midwest (Panel C), rates have consistently been the highest within large central metro counties, but as with the Northeast, rates have increased the most (185%) in micropolitan counties in the Midwest. In the South (Panel D), rates are highest in large fringe metro and medium metro counties, but increases were larger in small metro and micropolitan counties. Finally, in the West (Panel E), rates have consistently been higher in small and medium metro and nonmetro counties since the mid-2000s, and increases across all categories of metropolitan status in the West have been smaller than the increases observed in the other three regions.

However, these regional patterns do not reveal the full story. There is also tremendous variation *within* rural areas. Fig. 2 shows opioid-related mortality rates for 2012–2016 among only the rural counties within each state. Rural opioid-related mortality rates are highest throughout central Appalachia, New England, New Mexico, and Utah, and lowest in the south and upper Great Plains. At 32.3 deaths per 100,000 population (2012–2016), collectively the rural counties in West Virginia had the highest opioid-related mortality rates but rural mortality rates were very low in other states, including Nebraska, South Dakota, and North Dakota with rural mortality rates of 2.2, 3.9, and 4.0 per 100,000 respectively in 2012–2016. Increases in rural opioid-related mortality rates also varied considerably (Fig. 3), with the largest absolute increases since the early 2000s occurring in West Virginia, Ohio, Kentucky, and Connecticut, and the largest percentage increases occurring in New York, Ohio, Pennsylvania, and Wisconsin. Importantly, state- and/or county-level variation in cause-of-death reporting by medical examiners may contribute to state differences in opioid-related mortality rates, and deaths attributable to opioids are likely undercounted more in some states than in others (Ruhm, 2017a, 2017b).

Discussions of geographic differences in the opioid epidemic also typically fail to distinguish between the types of opioids involved. The effectiveness of particular interventions at reducing overdoses may vary depending upon the type of opioid (i.e., prescription, heroin, fentanyl) responsible for most deaths in an area. For example, prescription drug monitoring programs and physician training may be effective at preventing prescription opioid overdoses (Haegerich, Paulozzi, Manns, & Jones, 2014; Patrick, Fry, Jones, & Buntin, 2016; Rigg, March, & Inciardi, 2010), whereas naloxone distribution may be more effective at preventing heroin overdoses than fentanyl-related overdoses (Fairbairn, Coffin, & Walley, 2017). As shown in Fig. 4a, prescription opioids make up a larger share of rural drug-related deaths than either heroin or synthetic opioids. It is also noteworthy that since 2013, synthetic opioids (primarily fentanyl) have contributed to a larger share of rural drug-related deaths than heroin. As shown in Fig. 4b, heroin contributes to a larger share of urban than to rural drug overdoses. As of 2015, synthetic opioids contributed the largest share of drug overdoses in urban areas. The percentage of drug overdoses attributed to unspecified opioids has declined over time, especially in urban areas. Better medical examiner education about different types of opioids may explain this decline. Importantly, the majority of drug deaths involve multiple classes of drugs (Ruhm, 2017b), and alcohol is often a contributing factor in both accidental and intentional drug overdoses (Kaplan et al., 2013; Tesfazion, 2014).

Finally, existing discussions of rural opioid mortality typically ignore racial/ethnic differences. Despite a common misconception, rural does not automatically equate to white. Racial/ethnic minorities comprise over 20% of the rural population, and rural racial/ethnic diversity is expected to increase due to rural Hispanic population growth (Lichter, 2012). This is important because rural racial/ethnic minorities are geographically concentrated, with most rural blacks living in the south, Hispanics in the southwest, and American Indians in the southwest and northwest (U.S. Census Bureau, 2015). If race/ethnicity is mentioned in rural opioid studies at all, it is usually to emphasize high rates of mortality among non-Hispanic whites. Among non-Hispanic whites, blacks, and American Indians, opioid mortality rates are higher in urban than in rural areas (Fig. 5). Among Hispanics, rates are comparable between rural and urban areas. With the exception of American Indians, rural racial/ethnic minorities have lower rates of opioid-related mortality than both rural and urban whites. Rural blacks have the lowest opioid-related mortality rate of any group. Research is needed to better understand the protective factors that contribute to especially low rates of opioid-related mortality among rural blacks. We encourage researchers to build on the descriptive analyses presented in this paper to more fully examine within-rural variation in the causes and consequences of the opioid epidemic.

Factors contributing to geographic heterogeneity in the opioid epidemic

Below we summarize three major groups of factors (infrastructural; demographic/socioeconomic; and social) that have likely contributed to higher prevalence of opioid-related mortality in the hardest-hit rural areas of the country. Moreover, despite the fact that opioid mortality rates are not disproportionately higher in rural versus urban areas, these factors may make addressing the epidemic in rural areas especially difficult.

Infrastructural factors

Drug treatment programs and providers

Addiction treatment services and providers are more limited in rural areas (National Rural Health Association Policy Brief, 2014, 2016; Oser et al., 2011; Rosenblatt, Andrilla, Catlin, & Larson, 2015). Moreover, rural hospitals, clinics, and treatment professionals are often dispersed across large geographic areas, making access difficult (Benavides-

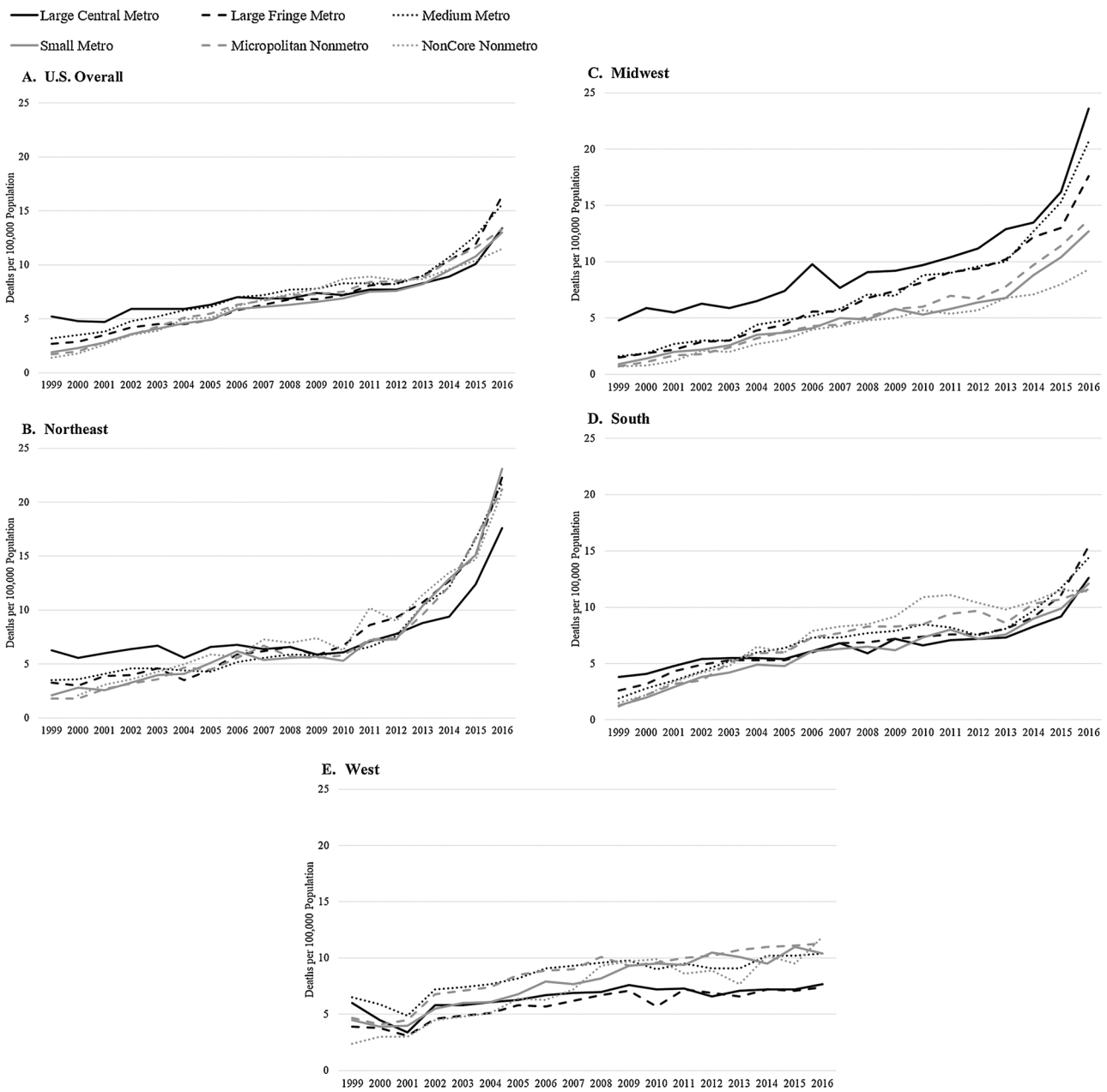

Fig. 1. Opioid-Related Mortality Rates, by Region and Metropolitan Status, 1999–2016.
Notes: Rates are age-adjusted deaths per 100,000 population; Includes all deaths with multiple cause of death codes for mental and behavioral disorders due to use of opioids (F11) and drug-specific codes for opium (T40.0), heroin (T40.1), other opioids (T40.2), methadone (T40.3), other synthetic narcotics (T40.4), and other and unspecified narcotics (T40.6); Metropolitan status categories are based on the 2013 National Center for Health Statistics (NCHS) Urban-Rural Scheme for Counties; Regions are based on the U.S. Census Bureau regional classification (https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf)
Data Source: U.S. Centers for Disease Control and Prevention. National Center for Health Statistics (NCHS). Multiple Cause of Death 1999–2016 on CDC WONDER Online Database, released December, 2017.

Vaello, Strode, & Sheeran, 2013). Lower salaries, limited opportunities for continuing education, longer hours, and fewer resources contribute to difficulty recruiting and retaining treatment providers in rural areas (Curran & Rourke, 2004; Daniels, VanLeit, Skipper, Sanders, & Rhyne, 2007).

Detoxification programs

Individuals seeking treatment for opioid addiction often require inpatient or medically supervised detox services to help ease withdrawal symptoms and facilitate a smooth transition into addiction treatment (Lenardson, Race, & Gale, 2009). Rural areas with small populations rarely have detox centers, which may force clients to self-detox without medical supervision. Lenardson et al. (2009) estimated that 80% of rural residents live in a county without a detox provider. Without the benefit of supervised detox programs, rural clients may be more likely to relapse or have an adverse reaction (e.g., death).

Medication assisted treatment

Medication-assisted treatments (MATs), such as buprenorphine and methadone, can be effective interventions for opioid addiction (Connery, 2015; Fullerton et al., 2014; Volkow, Frieden, Hyde, & Cha, 2014). However, the geographically uneven distribution of prescribers

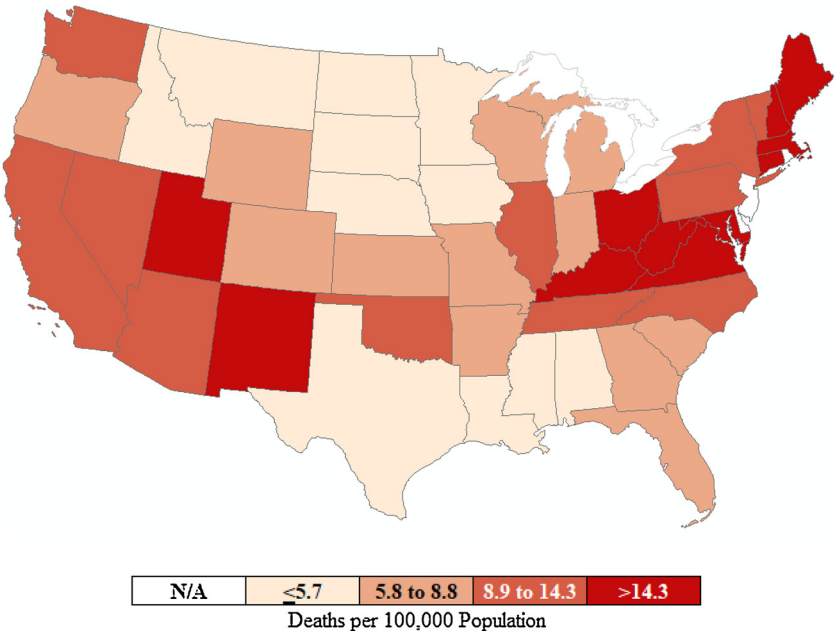

Fig. 2. Rural Opioid-Related Mortality Rates, by State, 2012–2016.
Notes: N/A = not applicable; Rates are age-adjusted deaths per 100,000 population Categorizations are based on quartiles; Rates include only rural (micropolitan nonmetro and noncore nonmetro) counties in each state. Excluded states (Delaware, District of Columbia, New Jersey, and Rhode Island) have no nonmetro counties and are represented with N/A on the map; Rates include all deaths with multiple cause of death codes for mental and behavioral disorders due to use of opioids (F11) and drug-specific codes for opium (T40.0), heroin (T40.1), other opioids (T40.2), methadone (T40.3), other synthetic narcotics (T40.4), and other and unspecified narcotics (T40.6).
Data Source: U.S. Centers for Disease Control and Prevention. National Center for Health Statistics (NCHS). Multiple Cause of Death 1999–2016 on CDC WONDER Online Database, released December, 2017.

limits access for rural residents (Hing & Hsiao, 2014). Of the only 2.2% of physicians with Drug Enforcement Administration (DEA) waivers, 90.4% prescribe buprenorphine in urban areas (Rosenblatt et al., 2015). As of 2011, access to methadone was so limited in rural Washington that Medicaid was spending $3 million annually to transport rural patients to urban methadone clinics (Kvamme, Catlin, Banta-Green, Roll, & Rosenblatt, 2013). Long travel times and few public transportation options are also obstacles to receiving MAT (Quest, Merrill, Roll, Saxon, & Rosenblatt, 2012). These barriers are especially problematic for persons seeking MAT where frequent, often daily, clinic visits are required. This can lead to patients missing doses, which increases relapse risk.

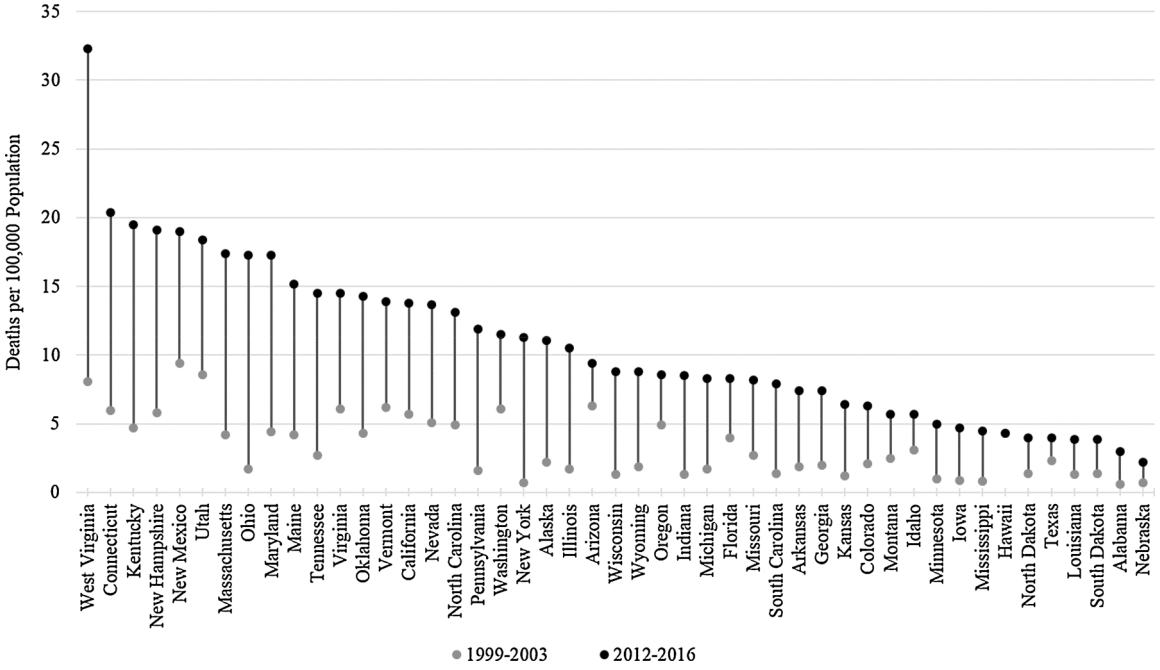

Fig. 3. Change in Rural Opioid-Related Mortality Rates, by State, 1999–2003 to 2012–2016.
Notes: Rates include only rural (micropolitan nonmetro and noncore nonmetro) counties in each state. The gray dot represents the pooled opioid-related mortality rate among rural counties in the state for 1999–2003. The black dot represents the pooled opioid-related mortality rate among rural counties in the state for 2012–2016. The bar represents the difference in rates between 1999–2003 and 2012–2016. Excluded states (Delaware, District of Columbia, New Jersey, and Rhode Island) have no nonmetropolitan counties.
Rates are age-adjusted deaths per 100,000 population. Includes all deaths with multiple cause of death codes for mental and behavioral disorders due to use of opioids (F11) and drug-specific codes for opium (T40.0), heroin (T40.1), other opioids (T40.2), methadone (T40.3), other synthetic narcotics (T40.4), and other and unspecified narcotics (T40.6).
Data Source: U.S. Centers for Disease Control and Prevention. National Center for Health Statistics (NCHS). Multiple Cause of Death 1999–2016 on CDC WONDER Online Database, released December, 2017.

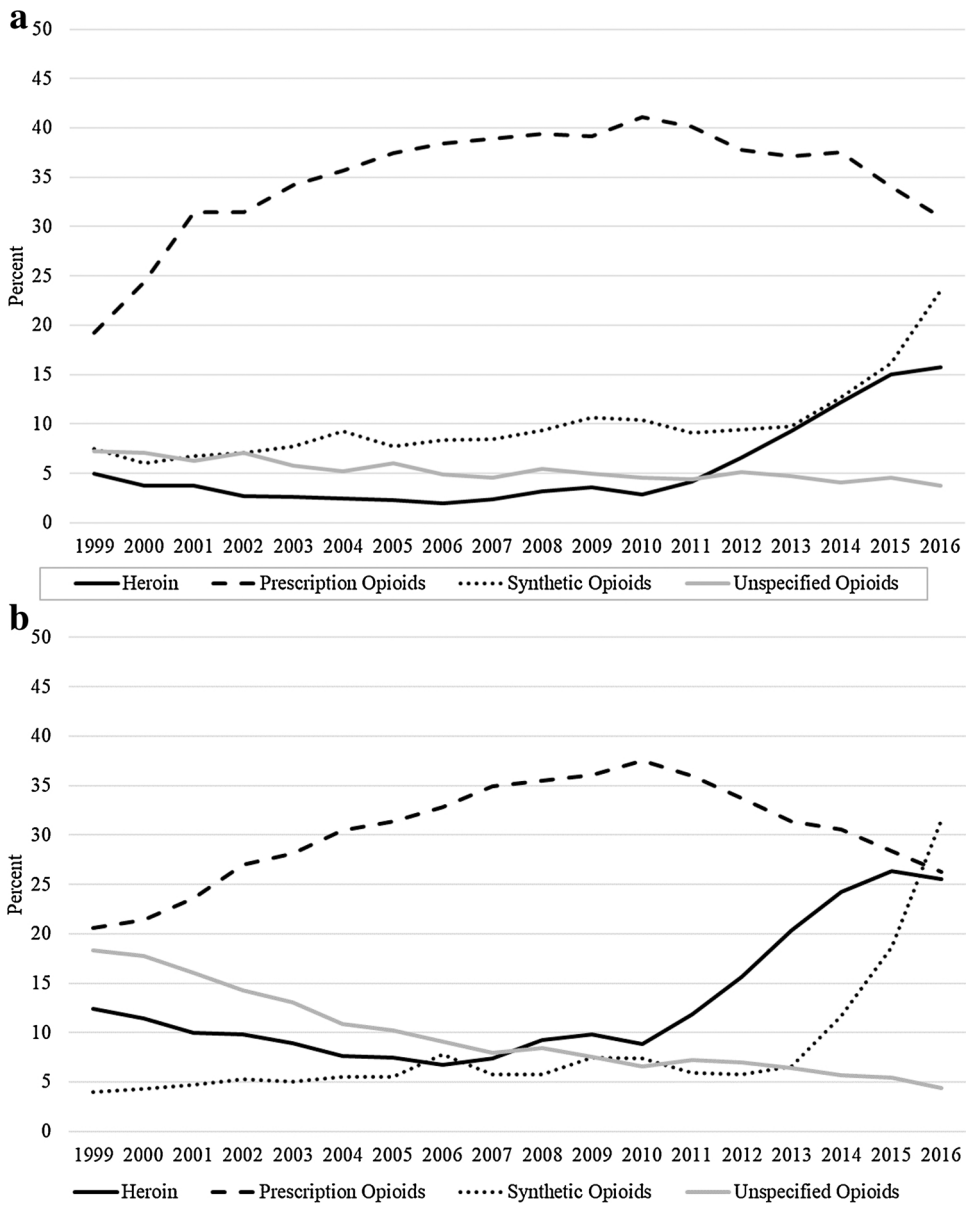

Fig. 4. a) Percentage of all Rural Drug Overdose Deaths Involving Heroin, Prescription Opioids, and Synthetic Opioids, 1999–2016. b) Percentage of all Urban Drug Overdose Deaths Involving Heroin, Prescription Opioids, and Synthetic Opioids, 1999–2016.

Notes: Rates are age-adjusted deaths per 100,000 population. Includes deaths with underlying causes of unintentional drug poisoning (X40-X44), suicide drug poisoning (X60-X64), or drug poisoning of undetermined intent (Y10-Y14), as coded in the International Classification of Diseases, 10th Revision. ICD-10 codes for specific opioids are as follows: heroin (T40.1), prescription opioids (T40.2, T40.3), synthetic opioids (T40.4), and other and unspecified narcotics (T40.6). Synthetic opioid deaths are dominated by fentanyl. Deaths can involve multiple drugs, so percentages are not mutually exclusive.

Rural includes micropolitan nonmetro and noncore nonmetro. Urban includes large central metro, large fringe metro, medium metro, and small metro.

Data Source: U.S. Centers for Disease Control and Prevention. National Center for Health Statistics (NCHS). Multiple Cause of Death 1999–2016 on CDC WONDER Online Database, released December, 2017.

Drug prevention programs

Drug prevention programs are a significant part of the national strategy to address the opioid epidemic. However, rural areas face barriers that may limit program effectiveness or preclude program implementation (Barnes, Holman, & Hunt, 2014). For example, population-size restrictions on evidence-based national programs and underdeveloped rural prevention workforces can hinder adoption (National Rural Health Association Policy Brief, 2014; Williams et al., 2010). Additionally, school-based prevention programs are largely developed with urban youth in mind. Curricula are rarely adapted to the norms, values, and cultures of rural communities, which likely diminishes their effectiveness (Colby et al., 2013; Rigg & Menendez, 2018).

Drug treatment courts

Another issue is the relatively low number of drug treatment courts (DTCs) in rural municipalities. DTCs are specialized courts where offenders are processed with their addiction in mind, unlike traditional courts that favor long prison sentences (Marlowe & Carey, 2010). DTCs involve a multidisciplinary team of criminal justice and treatment professionals who work together in order to provide a comprehensive treatment plan for addicted offenders (Moore, Barongi, & Rigg, 2017; Monchick, Scheyett, & Pfeifer, 2006). DTCs can be effective at making treatment linkages, and lowering substance use and criminal activity for offenders who are drug-involved (Chandler, Fletcher, & Volkow, 2009; Carey, Finigan, Crumpton, & Waller, 2006). Although there are now more than 3000 DTCs nationwide (Marlow, Hardin, & Fox, 2016), expansion has been much slower in nonmetropolitan areas, and these programs are still relatively rare in the most rural places. Therefore, whereas an urban-dwelling drug offender may be linked to treatment (and diverted from prison) via DTC, a rural resident is more likely to face traditional case processing and see prison time, exacerbating their addiction and increasing risk of overdose upon release (Binswanger, Blatchford, Mueller, & Stern, 2013).

Harm reduction programs

Harm reduction interventions, such as syringe service programs (SSPs), are less common in rural areas (Taylor, 2015). SSPs allow intravenous drug users to exchange used syringes for sterile ones and are

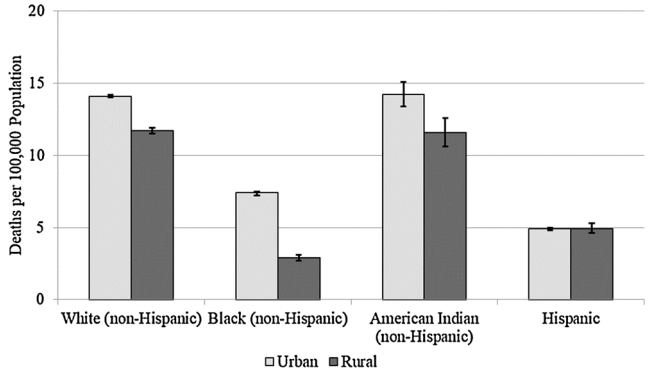

Fig. 5. Opioid-Related Mortality Rates, by Race/Ethnicity and Metro Status, 2012–2016.

Notes: Rates are age-adjusted deaths per 100,000 population. Error bars represent 95% confidence intervals. Includes all deaths with multiple cause of death codes for mental and behavioral disorders due to use of opioids (F11) and drug-specific codes for opium (T40.0), heroin (T40.1), other opioids (T40.2), methadone (T40.3), other synthetic narcotics (T40.4), and other and unspecified narcotics (T40.6). Rural includes micropolitan nonmetro and noncore nonmetro. Urban includes large central metro, large fringe metro, medium metro, and small metro.

Data Source: U.S. Centers for Disease Control and Prevention. National Center for Health Statistics (NCHS). Multiple Cause of Death 1999–2016 on CDC WONDER Online Database, released December, 2017.

effective at reducing the transmission of HIV and hepatitis C (Abdul-Quader et al., 2013). SSPs can also help reduce opioid overdoses by providing individuals in active addiction with access to basic healthcare, drug treatment, and naloxone (La Belle, 2017). Although the number of rural SSPs has increased, CDC recently documented unmet need for SSPs in rural Kentucky, West Virginia, Tennessee, and Virginia (Zibbell et al., 2015) – states that have among the highest opioid-related mortality rates in the U.S. The scarcity of rural harm reduction programs is partly due to a strong belief by residents that abstinence is the only acceptable approach to deal with addiction (Hathaway & Tousaw, 2008; National Rural Health Association Policy Brief, 2016).

Primary and emergency health care services

Rural residents face significant primary health care shortages, which may make routine preventive health checkups difficult, potentially leading to untreated injuries and chronic pain. Nearly two-thirds of uninsured rural residents live in a state that did not expand Medicaid (Newkirk, 2014), and rural residents have fewer insurance marketplace options than urban residents (Cox, Claxton, & Levitt, 2015). Together with rising incidence of rural hospital closures and tightening Medicare and Medicaid reimbursement rates, rural residents face increasing difficultly accessing basic health care. Poor access to primary health care forces rural residents to rely more on EDs (Haggerty, Roberge, Lévesque, Gauthier, & Loignon, 2014; Haggerty, Roberge, Pineault, Larouche, & Touati, 2007), where opioid prescribing is more prevalent (Hoppe, Nelson, & Perrone, 2015). Geographic isolation also presents challenges for emergency vehicles to quickly reach residents experiencing overdose. Overdose antidotes such as naloxone must be administered soon after opioid consumption to be effective.

The emergence of synthetic opioids

As of 2016, synthetic opioids (including fentanyl and its analogues), surpassed heroin as the largest contributor to opioid-related deaths. Illicitly manufactured fentanyl (up to 100 times more potent than morphine) is often mixed with heroin because fentanyl is cheaper and more potent. In addition to its high potency, some fentanyl analogues can render naloxone less effective, increasing the likelihood of unsuccessful overdose treatment (Carter, 2017; Grant, 2017; Guerrieri, Rapp, Roman, Druid, & Kronstrand, 2017). There is wide geographic variation in the concentration of synthetic opioids. Six of the top 10 states in fentanyl confiscation (Ohio, Massachusetts, Pennsylvania, New Jersey, New Hampshire, and Indiana) are located in the Northeast or Midwest (CDC, 2015). The disproportionate concentration of synthetic opioids in these regions is an important contributor to the region's higher overdose rates relative to other regions (CDC, 2016).

Demographic and socioeconomic factors

Demographic and socioeconomic composition

Rural areas are home to disproportionate shares of at-risk groups, including American Indians, military veterans, older adults, persons with disabilities, and the poor (Van Gundy, 2006). Monnat (2018) found that each of these compositional factors are associated with higher county-level drug mortality rates. Socioeconomic disadvantage can increase risk of substance use, in part through distress, hopelessness, and lack of control (Adler & Newman, 2002). Economic insecurity also contributes to family breakdown and social disorganization, undermining important supports against substance use (Sherman, 2009; Yen & Syme, 1999). In 2015, nearly 17% of rural residents were living in poverty compared to 13% of urban residents (Proctor, Semega, & Kollar, 2016). Poverty is persistently high in some rural areas, especially central Appalachia, the Delta South, the Rio Grande Valley, and Native-American reservations (U.S. Department of Agriculture and Economic Research Service, 2016).

Manual labor jobs

Residents of rural communities are also more likely to work in manual labor jobs than their urban counterparts (McGranahan, 2003). Physically demanding and injury-prone jobs like farming, fishing, forestry, construction, and mining place workers at risk for disability and/or chronic pain (Coben, Tiesman, Bossarte, & Furbee, 2004; Keyes et al., 2014). In Appalachia and the Ozarks, for example, disability claims are 60% above the national average (Van Gundy, 2006). OxyContin and other strong opioids were heavily marketed in mining-dependent Appalachian communities long before they spread across the rest of the U.S. (Keyes et al., 2014, Quinones, 2015). In fact, with such close ties to this region, OxyContin was once referred to as "hillbilly heroin" (Inciardi & Cicero, 2009).

Macroeconomic change

Some have described opioid-related mortality as "deaths of despair" and suggested that the opioid epidemic is linked to economic dislocation, social isolation, and place-level downward mobility, particularly among working-class non-Hispanic whites (Case & Deaton, 2017; Dasgupta, Beletsky, & Ciccarone, 2018; Monnat, 2016). The past two-decade increase in opioid-related mortality has corresponded with significant economic stressors in some rural areas. Rural labor markets are less diversified than urban labor markets, making them more vulnerable to economic shifts (Brown & Schafft, 2011; Lichter & Schafft, 2016). Over the past 40 years, employment restructuring has led to the movement of many livable-wage production jobs out of rural areas and the concentration of high-wage high-skill service, finance, and technology-based employment in urban cores (Bailey, Jensen, & Ransom, 2014). This has resulted in wage polarization (Peters, 2012) with fewer and lower-wage employment opportunities for rural residents (Burton, Lichter, Baker, & Eason, 2013; Slack, 2014). Unstable labor markets are associated with higher prevalence of substance use (Kerr et al., 2017; Pierce & Schott, 2016). Additionally, selective out-migration of the "best and brightest" (Carr & Kefalas, 2009) has intensified the disproportionate geographic clustering of multigenerational economic

distress in rural counties (Iceland & Hernandez, 2017; Lichter & Schafft, 2016). Economic disadvantage can contribute to collective frustration and hopelessness, community disinvestments, infrastructural decay, crime, and substance use (Brown & Swanson, 2003; McLean, 2016; Smith & Tickamyer, 2011). High rates of opioid-related mortality may reflect collective stress, anxiety, and hopelessness that are symptomatic of place-level economic precarity.

Social factors

Stigma

Although stigma is not unique to rural communities, it can be pronounced in small towns (Borders & Booth, 2007; Wrigley, Jackson, Judd, & Komiti, 2005). Difficulty maintaining anonymity in communities where "everyone knows everyone" can sometimes cause people to discontinue treatment or avoid it altogether (Gamm, Stone, & Pittman, 2010; Rost, Smith, & Taylor, 1993). Rural clients are also faced with greater likelihood of friends or family members working as service providers (e.g., social worker, case manager, intake worker), than are residents in larger urban areas. The potential embarrassment of being outed as a "junkie" or "addict" can be a powerful deterrent to seeking help in some small towns (Hastings & Cohn, 2013).

Social capital

Social interaction through churches, community associations, and recreational facilities can facilitate linkages, trust, goodwill, and social cohesion, which may buffer against substance use (Putnam, 2001; Yen & Syme, 1999). On average, rural communities may be advantaged by their comparatively higher community attachment and social capital, but there is wide divergence in social capital across the U.S., with Midwestern counties having much more social capital than other rural regions (Rupasingha, Goetz, & Freshwater, 2006). Some rural communities lack recreational opportunities, which is a known risk factor for substance use, especially for youth (Van Gundy, Stracuzzi, Rebellon, Tucker, & Cohn, 2011; Van Gundy, 2006). Social and civic organizations and organized sports can be difficult to sustain in residentially dispersed areas (Pate, Trost, Levin, & Dowda, 2000). Opportunities for social interaction may be limited to family, church, work, and bars (Slama, 2004). Fewer opportunities for social interaction may contribute to rural residents becoming drug involved at younger ages than urban residents (Coomber et al., 2011; Gomez & Pruitt, 2016; Young, Havens, & Leukefeld, 2012).

Family can also play a role. Although strong family support can improve odds of recovery (Warren, Stein, & Grella, 2007), social and kinship networks in rural areas also facilitate prescription drug diversion (Keyes et al., 2014; Monnat & Rigg, 2016). Rural residents report knowing extended family members and social networks longer, feeling more connected to them, and trusting them more (Costa & Kahn, 2003; Beggs, Haines, & Hurlbert, 1996). Rural families are also larger (Glasgow, 1988). Larger and stronger kinship and peer networks may facilitate sharing, selling, and trading prescription opioids (Keyes et al., 2014). Research suggests that parents, relatives, friends, or acquaintances are among the primary diversion sources of pharmaceutical opioids (Eaton, 2017; Keyes et al., 2014; Rigg, Kurtz, & Surratt, 2012). Jonas, Young, Oser, Leukefeld, and Havens (2012) further notes that in regions with widespread and intergenerational economic disadvantage, like rural Appalachia, opioids can serve as a form of currency that is associated with increased social capital.

Strategies for addressing the opioid epidemic in rural areas

Strategies for addressing the opioid epidemic need to consider treatment, recovery, harm reduction, and prevention, and must encompass both downstream and upstream approaches. Downstream, extended release formulations of MATs have potential to improve rural treatment options. For example, an injectable extended release formulation of naltrexone and an implantable formulation of buprenorphine are now available (Knopf, 2016; Krupitsky et al., 2011). The buprenorphine implant (Probuphine), can deliver up to six months of opioid maintenance, drastically reducing the need for treatment visits (Barnwal et al., 2016). This could help minimize transportation barriers that prevent some rural patients from receiving treatment. Additionally, Probuphine reduces risk of diversion and misuse, and increases medication adherence. Physicians in rural areas who are reluctant to prescribe oral formulations of buprenorphine may be more amenable to treating patients with the implant. Initiatives aimed at educating rural doctors about Probuphine and how to properly implant it are still needed (Shakerdge, 2016). Given higher rates and faster growth of incarceration in rural versus urban areas (Kang-Brown & Subramanian, 2017), initiation of MAT for incarcerated persons and its continuation post-release may also hold promise for reducing overdoses among the formerly incarcerated (Green et al., 2018).

Telehealth (e.g., videoconferencing, chat, text messaging, webinars) can dramatically expand rural access to drug treatment services by "virtually" linking patients to clinicians in other parts of the country (Hall & Huber, 2000; Griffiths, 2005; Substance Abuse & Mental Health Services Administration, 2016). These technologies can mitigate workforce shortages, geographic isolation, and funding shortfalls that often plague rural areas. Telehealth is not new, but it is underutilized in rural areas due to provider concerns about privacy, reimbursement, start-up costs, and technical difficulties (Wynn & Sherrod, 2012). This highlights the need for increased efforts to incentivize and train rural practitioners on telehealth services. Research is needed on how to tailor telehealth programs so that utilization and outcomes for rural patients are improved (Jennett et al., 2003; Wade, Soar, & Gray, 2014).

Unmanned aerial vehicles (drones) also present new treatment opportunities (Landhuis, 2016). Drones have been used to deliver medication and supplies to patients in remote parts of rural Virginia (Sorrell, 2015). This same technology could be used to provide addiction services. Rather than repeated visits to a clinic, maintenance medications could be delivered directly to patients, providing greater access to geographically isolated residents. Current Federal Aviation Administration (FAA) regulations, however, make it difficult for this technology to be adopted and implemented more widely in the U.S. Unlike other countries (e.g., Netherlands), the U.S. places strict limits on the weight of drones and the distances they can travel (Marshall, 2016).

A more robust cadre of behavioral health practitioners in rural communities is critical to curbing the opioid epidemic. With the opioid epidemic expected to worsen with the widespread dispersion of synthetic opioids, efforts to recruit and retain clinicians to rural places must be more aggressive and innovative. For example, additional funding could be allocated for programs to recruit practitioners to the hardest hit rural areas, especially those with impending factory or mine layoffs or closures, where residents may be at higher risk (Alexander, 2017; Chen, 2015; Quinones, 2015). These initiatives should target experienced clinicians, as well as soon-to-be and recent graduates. Efforts could include scholarships, fellowships, loan repayment, tax breaks, or financial remuneration for those who commit to relocate to rural communities. Pharmaceutical companies (who helped to fuel the opioid epidemic) (Quinones, 2015) and the private sector (who are experiencing economic burdens from this epidemic), could help to fund some of these initiatives.

Rural areas are lacking harm reduction services needed to support intravenous opioid users. This leaves these residents at greater risk of overdose and infectious disease. Harm reduction programs (e.g., SSPs, supervised injection facilities) could reduce rates of opioid overdose and infectious disease via linkage to drug treatment, and wider distribution of naloxone and sterile syringes. Indeed, there is precedent for successfully implementing these programs in some rural regions. For example, Kentucky has been a leader in the establishment of SSPs in

rural areas as a strategy for preventing infectious disease outbreaks (Kentucky Department for Public Health, 2017). Likewise, Indiana implemented a SSP to head off an HIV outbreak in rural Scott County that was linked to intravenous opioid use (Rich & Adashi, 2015). The program in Scott County was successful in stabilizing the outbreak and connected many residents to treatment. The Comer Family Foundation also recently published a guidebook for establishing SSPs in at-risk rural areas (La Belle, 2017). Efforts to increase the acceptance of these programs among rural residents and policymakers are important in this process (National Rural Health Association Policy Brief, 2016). Reducing legal and regulatory barriers to funding these programs are also key.

Thus far, solutions to the epidemic have disproportionately focused on downstream efforts aimed at persons addicted to opioids. This highlights the need for a concomitant focus on upstream strategies that also emphasize prevention. Upstream approaches, like school-based prevention programs are lacking in rural areas, and more funding is needed for schools to not only purchase evidence-based curricula, but to properly train facilitators so that programs are properly implemented and tailored (Gale, Hansen, & Williamson, 2017; National Rural Health Association Policy Brief, 2014; Rigg & Menendez, 2018). Improving physician training regarding appropriate opioid prescribing is another important upstream strategy. Education on proper opioid prescribing and addiction issues is lacking in medical education (Silverman, 2016). Prescriber education may be particularly relevant for rural areas as there is evidence that rural doctors prescribe opioids more liberally than their non-rural counterparts (Prunuske et al., 2014).

Prescription drug monitoring programs (PDMPs) also bear mention as an upstream strategy because of their ability to detect diversion and overprescribing. Unfortunately, PDMPs have been underutilized and still need a great deal of perfecting before their full potential is realized (Haffajee, Jena, & Weiner, 2015; Kreiner, Nikitin, & Shields, 2014). To this end, states would do well to institute mandatory use for prescribers, eliminate lag time between data entry and availability, and share data across state lines.

Ultimately, however, the most important upstream solution may well be a revitalized economy and social safety net. It is no coincidence that overdose rates are highest in places with the most disadvantaged labor markets that have hemorrhaged jobs over the past three decades (Monnat & Brown, 2017). Therefore, existing interventions are unlikely to be effective without addressing the underlying social and economic determinants, including poverty, unemployment, and declining opportunities for upward mobility (Dasgupta et al., 2018).

Conclusion

Opioid-related mortality rates have reached epidemic levels in some rural counties. However, as we have shown, there is substantial diversity across rural America, and failing to account for this variation may lead to the misdirection of resources and inappropriate solutions. Policy initiatives thus far have been largely ineffective at addressing the opioid epidemic in many of the hardest hit rural communities, and the recent surge in fentanyl-related overdoses in large urban areas (Bode, Singh, Andrews, Kapur, & Baez, 2017; Gladden, Martinez, & Seth, 2016) may be a precursor of what to expect in at-risk rural areas in coming years. The information presented in this paper dispels the myth that the opioid epidemic is disproportionately rural, and demonstrates that the magnitude of the epidemic has varied considerably across different rural areas. As such, this paper provides important insights for public health professionals, treatment practitioners, researchers, and policymakers as they work toward solutions that take into account the diversity of rural communities and the dynamic nature of the opioid epidemic.

Conflicts of interest

None.

Appendix A. Description of Data and Methods.

Data came from the U.S. Centers for Disease Control and Prevention's Wide-Ranging Online Data for Epidemiologic Research (WONDER) multiple cause-of-death (MCD) files, 1999–2016 (U.S. Centers for Disease Control and Prevention, 2017). Opioid-related deaths were those with *International Statistical Classification of Diseases, 10th revision* (*ICD-10*) codes of F11 (mental and behavioral disorders due to use of opioids) or specific drug codes of T40.0 (opium), T40.1 (heroin), T40.3 (other opioids), T40.3 (methadone), T40.4 (other synthetic narcotics), and T40.6 (other and unspecified narcotics). All rates presented are age-adjusted and represent the number of deaths per 100,000 population. When presenting opioid-related mortality rates, we include deaths with any underlying cause that also identify one of the opioid codes as a contributing cause. When presenting the percentage of drug overdoses that involve opioids, we include only deaths with underlying causes of unintentional drug poisoning (X40-X44), intentional drug poisoning (X60-X64), and drug poisoning of undetermined intent (Y10-14).

Urban-rural classification was based on the National Center for Health Statistics (NCHS) 2013 Urban-Rural Classification Scheme for Counties (National Center for Health Statistics, 2017), which are derived from the Office of Management and Budget's (OMB) delineation of metropolitan statistical areas (MSA) and micropolitan statistical areas. MSAs include one or more counties containing a core urban area of 50,000 or more people, together with any adjacent counties that have a high degree of social and economic integration (as measured by commuting to work) with the urban core. Micropolitan statistical areas are defined in the same way, except that they are labor market areas centered on an urban cluster with a population of 10,000–49,999. Micropolitan counties are nonmetropolitan. The NCHS urban-rural classifications are as follows: (1) Large central metro are counties in MSAs of 1 million or more population that a) contain the entire population of the largest principal city of the MSA, or b) are completely contained within the largest principal city of the MSA, or c) contain at least 250,000 residents of any principal city in the MSA. (2) Large fringe metro are remaining counties in MSAs of one million or more that do not qualify as central metro. (3) Medium metro are counties in MSAs of 250,000–999,999 population. (4) Small metro are counties in MSAs of less than 250,000 population. (5) Micropolitan are nonmetropolitan counties that OMB designates as belonging to a micropolitan statistical area. (6) Finally, noncore are the remaining nonmetropolitan counties that do not belong to a micropolitan statistical area. Throughout, we refer to metropolitan counties (categories 1–4) as urban and nonmetropolitan counties (categories 5 and 6) as rural.

Fig. 1 presents time series trends in opioid-related mortality rates (1999–2016) by urban-rural classification overall and by U.S. Census Bureau Region. Fig. 2 is a map that shows the geographic distribution of opioid-related mortality rates by state in rural counties only (pooled for 2012–2016 for greater stability). Categorizations represent mortality rate quartiles. Fig. 3 shows the opioid-related mortality rate pooled for all rural counties within each state for 1999–2003 and 2012–2016. The bar represents the difference (growth) in the mortality rate between those two time periods. Fig. 4a and 4b are time series charts (1999–2016) showing the percentages of all rural and urban drug overdose deaths that involve heroin, prescription opioids, synthetic opioids (fentanyl and fentanyl analogs), and unspecified opioids. Finally, Fig. 5 shows the most recent opioid-related mortality rates (2012–2016) separately for urban and rural non-Hispanic whites, non-Hispanic blacks, non-Hispanic American Indians, and Hispanics. Error bars are shown to represent 95% confidence intervals.

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