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The Impact of Prescription Pain Reliever Misuse and Heroin Use on Morbidity and Mortality by Level of Urbanicity: 2002-2014

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Abstract. Non-medical use of prescription pain relievers (PPRs), heroin, and more recently fentanyl, continue to have major public health consequences in the United States. This article analyzes trends in PPR and heroin use, emergency department and hospital stays, substance use treatment services, and mortality to assess the relative impact of the opioid crisis on rural versus more urbanized counties in the United States. Our findings suggest that while more urbanized counties have had greater increases in opioid use, rural and less urbanized counties tended to be more negatively impacted than larger and non-rural counties. Disparities in service availability highlight the need for a serious discussion on how resources are allocated in counties that have lower tax bases. Based on these results, we conclude that rural and less urbanized counties can benefit from real increases in resources for substance use prevention and treatment services, including the expansion of prescribers trained to screen and treat opioid use. Understanding the unique challenges of rural and less urbanized counties may help decrease the disparity in consequences found in this study.

Keywords: rural-urban opioid use, rural services, morbidity, mortality, urbanicity

The consequences of the non-medical use of prescription pain relievers (PPR), heroin, and more recently fentanyl, continue to be a major concern of public health experts across the United States. These consequences include increases in the demand for opioid treatment (Jones, Campopiano, Galdwin, & McKance-Katz E., 2015; Liebling et al., 2016; Wu, Zhu, & Swartz, 2016) and hospital services, (Coben et al., 2010; Milard, 2007; Neven et al., 2016; Owens, Barrett, Weiss, Washington, & Kronick, 2016), growing numbers of infants born with neonatal abstinence syndrome (Patrick, Davis, Lehmann, & Cooper, 2015), and concerns over the rising rates of HIV and Hepatitis C, especially among individuals who transition from the non-medical use of prescription drugs to intravenous heroin use (Dunn et al., 2016; Klevens, Hu, Jiles, Holmberg, 2012; Rudd, Aleshire, Zibbell, & Gladden, 2016). Though data from the National Survey on Drug Use and Health (NSDUH) show a decline in the use of PPRs from a high of 5.3 million individuals 12 and older in 2009 to 4.3 million individuals in 2014 (Substance Abuse and Mental Health Services Administration [SAMHSA], 2015), researchers report that there has also been an increase in the incidence of prescription opioid use disorders (Han, Compton, Jones, & Cai, 2015). During the same time period, past year

and past month use of heroin has more than doubled (126% and 162% increase respectively) (Center for Behavioral Health Statistics and Quality [CBHSQ], 2016a; Cicero & Kuehn, 2014).

Though some research suggests that PPR use may be lower in non-metropolitan and rural areas (Roman, Abraham, & Knudsen, 2011), these findings may conceal significant variation in use and consequences that may exist within urbanized, less urbanized, and completely rural non-metropolitan areas when these communities are dichotomized into rural and urban communities. Further, by distinguishing communities by population and size of areas, there is potential for creative responses that are more consonant with the unique nature of rural communities (Brems, Johnson, Warner, & Roberts, 2006; Talebreza-May, Jensen, & Shay, 2017). Examining and understanding the differences in the rate and consequences of PPR use across geographic areas is a critical part of advocating for qualitatively different services in terms of needs and delivery systems (Pullen & Oser, 2014).

Background

The opioid epidemic, driven primarily by the non-medical use of PPRs through 2014, has often been associated with increases in opioid use in rural settings (Van Gundy, 2006). This may be in part because of the data which show that chronic pain injury is more common in rural areas and that per capita sales of opioid prescriptions are higher in states with significant rural populations (Corso & Townley, 2016). However, data also show that overall substance use in rural areas, including opioid use, is not significantly different from urban areas (Brooks, Mcbee, Pack, & Alamian, 2017) and may in fact be slightly lower than in more densely populated areas of the country; except for underage drinking and methamphetamine use, which is somewhat higher (Lambert, Gale, & Hartley, 2008), especially among youth and young adults (Khary & Rigg, 2015).

Rural communities differ in many ways from urban communities, including higher levels of poverty and child poverty (Flurharty, 2002) and social and cultural isolation (Lee, 2016) in rural areas. In addition, there are many factors that create challenges in providing substance use treatment services including limited access to providers willing to prescribe opioid agonist medications and limited service infrastructure (Pullen & Oser, 2014; Walley et al., 2008). Individuals in rural communities may face additional hurdles ranging from a limited number of facilities (Corso & Townley, 2016) to geographic service isolation which requires reliance on family and friends for transportation (Faul et al., 2015; Humble, Lewis, Scott & Herzog, 2013; Pullen & Oser, 2014). Many may place a higher priority on basic medical and dental care service needs than on treatment for drug use (Fortney, Burgess, Bosworth, Booth, & Kaboli, 2011). Recent research has highlighted a number of themes, in addition to service availability, that can create barriers to substance use treatment in rural communities including access to technology that can support treatment services (Browne et al., 2016) service costs, and stigma (Broffman et al., 2016). Personal views of treatment for substance use and health care in general and a lack of anonymity can exacerbate how stigma and access issues affect health care decisions (CBHSQ, 2015).

Given the increasing number of individuals with opioid use disorders and the disparity in

the capacities of counties to respond to this ongoing epidemic, there is value in assessing the relative impact on two of the more severe consequences of this epidemic, morbidity and mortality. This article analyzes data from national survey systems by level of urbanization to provide a contextual understanding of how opioid use, specifically the misuse of prescription pain relievers (PPRs) and heroin, differentially affects populations at different levels of urbanization to better inform policy and program decisions to address service needs of individuals with opioid use disorders with particular attention to the implications for practice in rural settings. The analysis was purposely limited to PPR and heroin during the period of 2002-2014, in part, because of changes in the major survey on drug use and also to provide clarity to the analysis.

Method

We used data from national surveys on drug use and treatment services, administrative data on health care use, authorized prescribers, and morbidity and mortality related to PPR and heroin use. Additionally, we were able to include data provided by Federal partners and online sources.

Staff from the CBHSQ at the SAMHSA provided data on trends in past year PPR misuse from the National Survey on Drug Use and Health (NSDUH). The NSDUH provides national and state-level estimates of the use of illicit drugs, including nonmedical use of prescription drugs, alcohol, and tobacco among civilian, noninstitutionalized populations aged 12 years and older in the United States. Data for this study included the number and percentage of individuals who misused PPRs for the period 2002-2014. Data from subsequent years was not included in this analysis as the NSDUH was redesigned in 2015 and the data were not comparable.

Data from the Behavioral Health Treatment Locator files (found at <https://findtreatment.samhsa.gov>) were downloaded and analyzed to identify substance use treatment and opioid treatment capacity across the United States. These files use data from the National Survey of Substance Abuse Treatment Services (N-SSATS), an annual survey of public and private treatment facilities, including opioid treatment programs, that collects information on facility characteristics, client counts by service type, and licensure and accreditation from facilities in the United States (SAMHSA, 2014).

The Drug Enforcement Administration provided de-identified administrative data on physicians granted waivers to prescribe buprenorphine outside of opioid treatment programs in February of 2016.

We used the *faststats* online tool provided by the Agency for Healthcare Quality and Research (AHRQ) Healthcare Cost and Utilization Project (HCUP) to extract the number of PPR and heroin-related emergency department visits and inpatient stays. HCUP includes a number of administrative datasets on inpatient stays, ambulatory care services, and emergency department visits. We used data from the Nationwide Emergency Department Sample (NEDS) (AHRQ, 2016) and from the Nationwide Inpatient Sample (NIS) (Houchens, Ross, Elixhauser, & Jian, 2014) for the years 2005-2014.

The total the number of opioid-related emergency room visits and inpatient stays in HCUP was calculated using the following opioid-related diagnostic codes from the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) (DHHS, 2015)*:

- 304.00 – 304.02: Opioid type dependence (unspecified; continuous; episodic);
- 304.70 – 304.72: Combinations of opioid type drug with any other drug dependence unspecified; continuous; episodic);
- 305.50 – 305.52: Opioid abuse (unspecified; continuous; episodic);
- 965.00 – 965.02; 965.09: Poisoning by opium (alkaloids), unspecified; heroin; methadone; other opiates and related narcotics;
- E850.0 – E850.2: Accidental poisoning by heroin; methadone; other opiates and related narcotics;
- E935.0 – E935.2: Heroin, methadone, other opiates and related narcotics causing adverse effects in therapeutic use; and
- E940.1: Opiate antagonists causing adverse effects in therapeutic use.

ICD-9-CM diagnosis codes related to opioid dependence or abuse “in remission” were not used to identify opioid-related hospital use because remission does not indicate active periods of use.

For mortality, PPR and heroin-involved drug poisoning deaths for the years 1999 through 2016 were extracted from the Multiple Cause of Death (MCD) files released by the National Center for Health Statistics (NCHS) in 2017^a on the Centers for Disease Control and Prevention’s Wide-ranging Online Data for Epidemiologic Research (CDC/WONDER) online information system. The MCD files contain mortality and population counts for all U.S. counties based on death certificates for U.S. residents compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Each death certificate contains a single underlying cause of death but also can contain up to twenty additional (multiple) causes as well as demographic data.

Drug poisoning deaths were identified using the *International Classification of Diseases (ICD), 10th Revision* (WHO, 1992). Drug poisoning deaths were selected using underlying cause of death ICD-10 codes X40-X44, X60-64, X85, and Y10-Y14. Then we used ICD-10 codes T40.2 to T40.4 and T40.6 to identify drug-poisoning deaths involving PPRs. Drug-poisoning deaths involving to heroin, including opium, were identified using ICD-10 codes T40.0 and T40.1.

* HCUP transitioned to the 10th edition of ICD (ICD-10-CM) in 2015, another reason for restricting this analysis to 2014 and earlier.

Data Analysis

Past Year Use of PPR and Heroin by Level of Urbanization

To estimate the number of past year users by urbanicity, we utilized generated counts and percentages provided by CBHSQ for the years 2002 to 2014 using the 2003 rural-urban continuum codes, also known as the Beale codes, developed by the U.S. Department of Agriculture (CBHSQ, 2016b). This provided three metro (Large, Medium, and Small) and three non-metro (Urbanized, Less Urbanized, and Completely Rural) levels of urbanization.

Substance Abuse Facilities, Substance Abuse Facilities with Opioid Treatment Programs, Number of Physicians Holding Waivers to Prescribe Buprenorphine, and Number of Drug Poisoning Deaths Related to Prescription Pain Relievers, by Level of Urbanization

We analyzed the number, percentage, and where appropriate the rate per hundred thousand across all 3,141 counties in the United States, by level of urbanization which is based on whether a county lies within a metropolitan statistical area (MSA), its population size, and whether it contains an urban population cluster. An MSA contains a core urban area of 50,000 population or more. This analysis uses the NCHS classification noted above (Ingram, & Franco, 2014) with the following six levels of urbanization, in decreasing order of population size:

- **Large central metro** — Counties in MSAs of 1 million or more population that: contain the entire population of the largest principal city of the MSA, or their entire population contained in the largest principal city of the MSA, or contain at least 250,000 inhabitants of any principal city of the MSA.
- **Large fringe metro** — Counties in MSAs of 1 million or more population that did not qualify as large central metro counties.
- **Medium metro** — Counties in MSAs with populations of 250,000 to 999,999.
- **Small metro** — Counties in MSAs with populations less than 250,000 but greater than 50,000;
- **Micropolitan** — Counties that contain one or more urban clusters (An urban cluster is a small version of an urbanized area with 2,500–49,999 inhabitants.); and
- **Non-core** — Non-metropolitan counties that did not qualify as micropolitan. This category is what we refer to as *the most rural* areas.

Opioid-Related Emergency Department Visits and Inpatient Hospital Stays

The number of opioid-related emergency department visits and inpatient hospital stays, which is calculated from HCUP county level data, is similar to the NCHS categories except it reports five categories, large central metro, large fringe metro, medium metro, small metro, micropolitan, and non-core, instead of the six above.

The data show that as urbanization decreases, the number of counties in the category classified as the most rural increases, with 42% of counties (1,333). Fifteen percent of the United States population (46 million) live in rural areas, and 6% of the total population (19 million) are in the most rural areas. In terms of land area, the most rural counties account for 53% of the national total, with an additional 19% in less rural counties. The average area of counties tends to increase with less urbanization to an average of 1,506 square miles for very rural counties, and the average county population density decreases from 1,318 persons per square mile in large central metropolitan areas to 9.4 in the most rural areas.

Results

Past-year PPR use has been decreasing nationally since 2006 and, over time, past year PPR use has generally been lower among non-metropolitan communities and lowest among completely rural communities. (see Table 1). By 2014, all county types saw a relative decrease in the percent of past year use except urbanized non-metropolitan counties which saw a 2.3% relative increase from 2002 in the percent of reported past year PPR use. Completely rural counties saw the largest relative decrease in percent of past year use if PPRs (-42.07 %).

Table 1

Percent of Past Year Nonmedical Use of Prescriptions Opioid Analgesics among Persons Aged 12 or Older by Level of Urbanization, 2002-2014

Year	United States	Large > 1 Million	Metro		Non-Metro		Completely Rural
			Medium (250k to 1 M)	Small <250k	Urbanized	Less Urbanized	
2002	4.67	4.56	4.96	5.70	4.58	3.69	3.95
2003	4.91	4.86	5.18	5.17	5.30	4.35	2.37
2004	4.68	4.38	5.27	5.26	4.94	4.41	4.14
2005	4.86	4.76	5.52	4.17	5.51	4.36	3.76
2006	5.14	5.10	5.68	5.01	5.26	4.18	5.30
2007	5.05	4.96	5.04	5.30	5.77	5.19	3.76
2008	4.77	4.73	4.90	5.56	4.39	4.33	3.38
2009	4.94	4.81	5.26	5.47	5.15	4.36	3.98
2010	4.83	4.81	4.94	5.21	4.94	4.40	3.03
2011	4.33	4.14	4.84	5.11	4.12	3.52	3.00
2012	4.80	5.00	4.78	4.81	4.46	4.09	2.63
2013	4.22	4.19	4.27	4.43	4.54	3.90	3.50
2014	3.90	3.87	3.92	4.38	4.69	3.10	2.29
Rel % Change ¹ (2002-2014)	-16.59	-15.08	-20.96	-23.17	2.30	-16.07	-42.07

¹ Difference statistics are based on non-rounded percentages.

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2002-2014.

Past year heroin use, though still a small percentage of drug use in the United States, doubled nationally from 0.17 % in 2002 to 0.34 % in 2014 (Table 2). Increases were seen across all county types except completely rural counties which saw a decrease from 0.3% in

2002 to 0.1% in 2014 (a -48.33 relative percent change). This may be because there is a much smaller market for heroin in less urbanized and completely rural counties compared to more urbanized counties. Indeed, past year use more than doubled in metro areas with a three-fold relative percent change in small metropolitan counties (206.94 %). Urbanized non-metropolitan and less urbanized non-metropolitan counties saw much smaller increases with (relative percent changes of 14.71% and 4.51 % respectively between 2002 and 2014).

Table 2

Percent Past Year Heroin Use Among Persons Aged 12 or Older, by County Type, 2002-2014

Year	United States	Large >1 Million	Metro Medium (250k to 1 M)	Small <250k	Urbanized	Non-Metro Less Urbanized	Completely Rural
2002	0.17	0.18	0.22	0.12	0.14	0.11	0.03
2003	0.13	0.19	0.05	0.07	0.08	0.07	0.04
2004	0.17	0.17	0.16	0.16	0.21	0.11	0.00
2005	0.16	0.17	0.14	0.16	0.09	0.16	0.01
2006	0.23	0.28	0.20	0.13	0.22	0.12	0.01
2007	0.15	0.15	0.12	0.21	0.16	0.15	0.14
2008	0.18	0.19	0.25	0.13	0.12	0.07	0.07
2009	0.23	0.23	0.31	0.24	0.13	0.06	0.11
2010	0.24	0.25	0.31	0.09	0.33	0.18	0.05
2011	0.24	0.31	0.15	0.16	0.26	0.09	0.01
2012	0.26	0.26	0.25	0.39	0.22	0.20	0.00
2013	0.26	0.30	0.23	0.16	0.19	0.22	0.37
2014	0.34	0.36	0.44	0.38	0.16	0.12	0.01
Rel % Change Change ¹ (2002-2014)	100.79	100.11	101.81	206.94	14.71	4.51	-48.33

¹ Difference statistics are based on non-rounded percentages.

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2002-2014.

Nationally, substance use treatment facilities, particularly opioid treatment program (OTP) facilities tend to be more available in in metropolitan counties than in less urbanized counties. Table 3 shows that one in ten large central metropolitan counties are without substance use treatment facilities while more than half (55 %) of non-core counties are without substance use treatment facilities. The percentage of substance use facilities is relatively similar across large fringe, medium metropolitan, small metropolitan, and micropolitan counties (between 72% and 76%). The disparity in treatment facilities is most apparent when we looked at the number of counties with and without OTPs. Eighty-eight percent of large central metropolitan counties have facilities with opioid treatment programs while micropolitan counties and non-core counties have a limited number of OTPs (9% and 1% respectively). Although more than non-metropolitan counties, large fringe, medium, and small metropolitan counties have many fewer OTP facilities than large central counties (30%, 35%, and 24% respectively). As a result, more rural communities have no programs that can provide medications such as methadone or buprenorphine to intervene with individuals with opioid use disorders and individuals with opioid use disorders will have to travel long distances or do without medication-assisted treatment as an option.

Table 3

Availability of Substance Use Treatment Facilities and Opioid Treatment Programs by Level of Urbanization, 2016

	Total Number Of Counties	Num (%) of Counties Without Substance Use Treatment Facilities	Num (%) of Counties Without Opioid Treatment Programs
Large Central Metro	68	7 (10%)	8 (12%)
Large Fringe Metro	368	88 (24%)	259 (70%)
Medium Metro	373	100 (27%)	242 (65%)
Small Metro	358	100 (28%)	267 (75%)
Micropolitan (non-metro)	641	157 (24%)	586 (91%)
Non-Core (non-metro)	1,333	728 (55%)	1,321 (99%)
United States	3,141	1,180 (38%)	2,683 (85%)

Sources: Data on facilities from the Substance Abuse and Mental Health Services Administration. National Survey of Substance Abuse Treatment Services information on the Behavioral Health Treatment Services Locator, available at <https://findtreatment.samhsa.gov/> accessed on February 10, 2016; county levels of urbanization from the National Center for Health Statistics classification.

One strategy to address the shortage of OTPs has been to expand access to medications such as buprenorphine within private medical practices. With the passing of the Drug Addiction Treatment Act of 2000 (DATA, 2000), physicians who receive specialized training could request a waiver to allow them to dispense buprenorphine from their medical office. However, a recent study found that there continue to be significant gaps at the state and national level between the need for providers who can dispense buprenorphine and the current capacity. We found these gaps to be much more pronounced when examining the differences by level of urbanization. All of the large central metropolitan counties had more than five doctors holding waivers to dispense buprenorphine while fewer than 340 (2%) of non-core (non-metropolitan) counties had more than five physicians holding waivers. Non-core counties also had the largest percentage of counties with no doctors holding a waiver for dispensing buprenorphine (72%). Interestingly, micropolitan counties had the highest percentage (52%) of counties with between 1 and 5 doctors holding buprenorphine waivers (Table 4).

Nationwide, between 2005 and 2014, the annual rate of opioid-related emergency department visits increased from 89.1 to 177.7 visits per 100,000. Emergency department data, disaggregated by level of urbanization, show that small metropolitan and rural counties had the lowest rates of opioid-related visits in 2005 but these rates more than doubled by 2014 (70.1 to 155.0 per 100,000 and 71.9 to 146.5 per 100,000 respectively). The rate of emergency department visits also had more than doubled in medium metropolitan counties between 2005 and 2014 (93.0 to 203.6 visits per 100,000) (Figure 1) (AHRQ, 2017a).

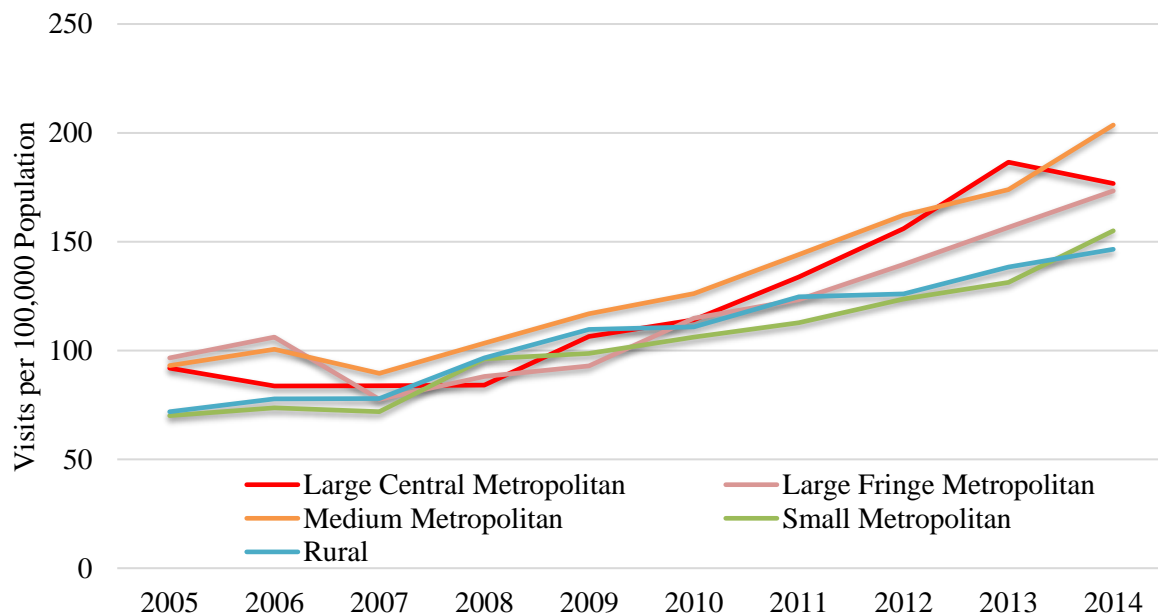
Table 4

Number and Percent of Physicians Waived to Dispense Buprenorphine by level of Urbanization, 2016

	Number of Counties	Number and Percent of Counties with Waived Physicians		
		No Waived Physicians	1-5 Waived Physicians	5 or more Physicians
Large Central Metro	68	0 (0%)	0 (0%)	68 (100%)
Large Fringe Metro	368	86 (23%)	107 (29%)	175 (48%)
Medium Metro	373	107 (29%)	86 (23%)	180 (48%)
Small Metro	358	113 (32%)	103 (29%)	142 (40%)
Micropolitan (non-metro)	641	219 (34%)	332 (52%)	90 (14%)
Non-Core (non-metro)	1,333	964 (72%)	340 (26%)	29 (2%)
United States	3,141	1,489 (47%)	968 (31%)	684 (22%)

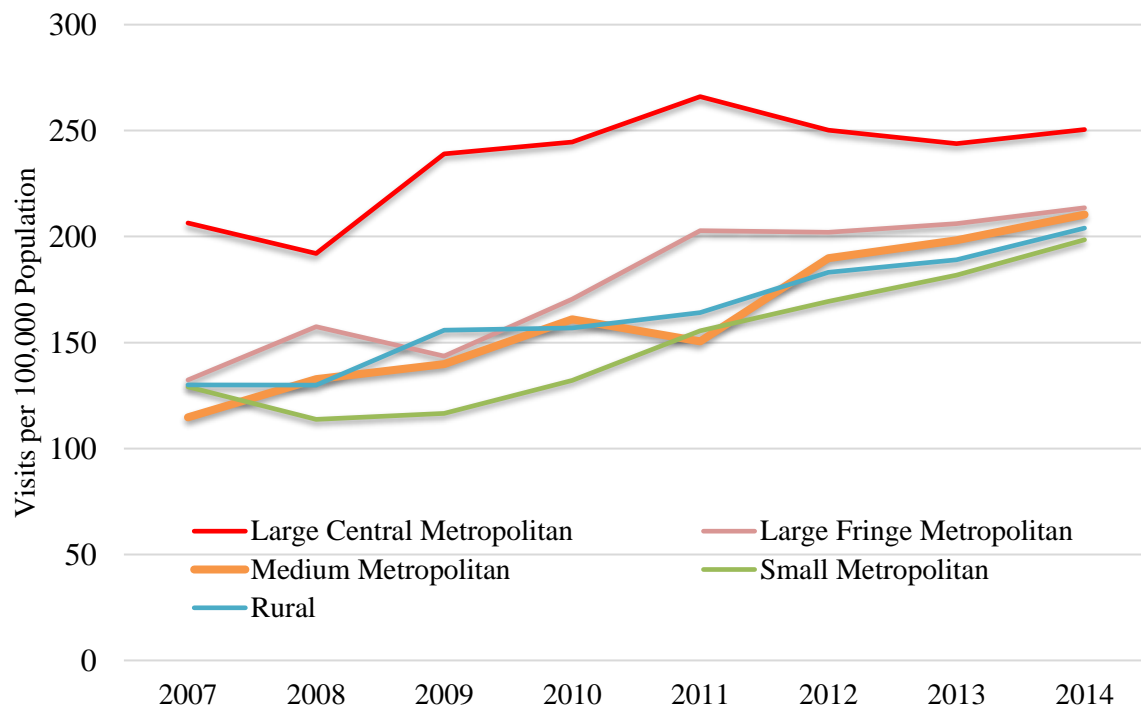
Sources: Data on physicians from the Drug Enforcement Administration, unpublished data as of February 16, 2016; county levels of urbanization from the National Center for Health Statistics classification.

From 2005 to 2014, the annual rate of opioid-related hospital inpatient stays increased by 64.2% nationwide. During this period, medium metropolitan (83%) and large fringe (61%) counties saw the largest increases in rates opioid-related hospital stays followed by rural (57%) and small metropolitan (54%) counties. By contrast, large central metropolitan counties saw an increase of 21% in the number of opioid-related hospital stays (Figure 2) (AHRQ, 2017b).



Source: Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project (HCUP), Nationwide Emergency Department Sample (NEDS). Downloaded from <https://www.hcup-us.ahrq.gov/faststats/OpioidUseServlet> on February 16, 2017.

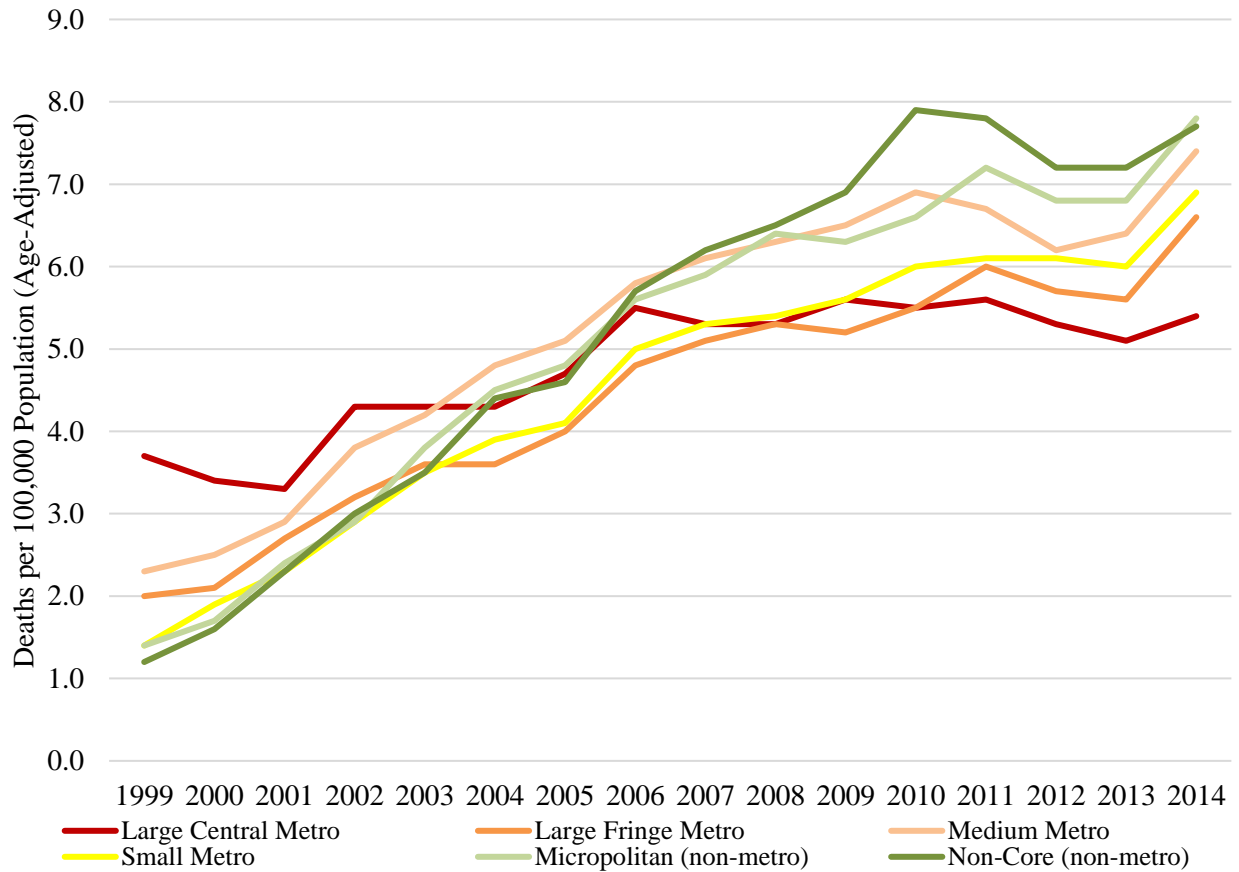
Figure 1. Opioid-Related Emergency Department Visits by Patient Location, 2005-2014



Source: Agency for Healthcare Research and Quality. Healthcare Cost and Utilization Project (HCUP), National (Nationwide) Inpatient Sample (NIS). Downloaded from <https://www.hcup-us.ahrq.gov/faststats/OpioidUseServlet> on February 16, 2017.

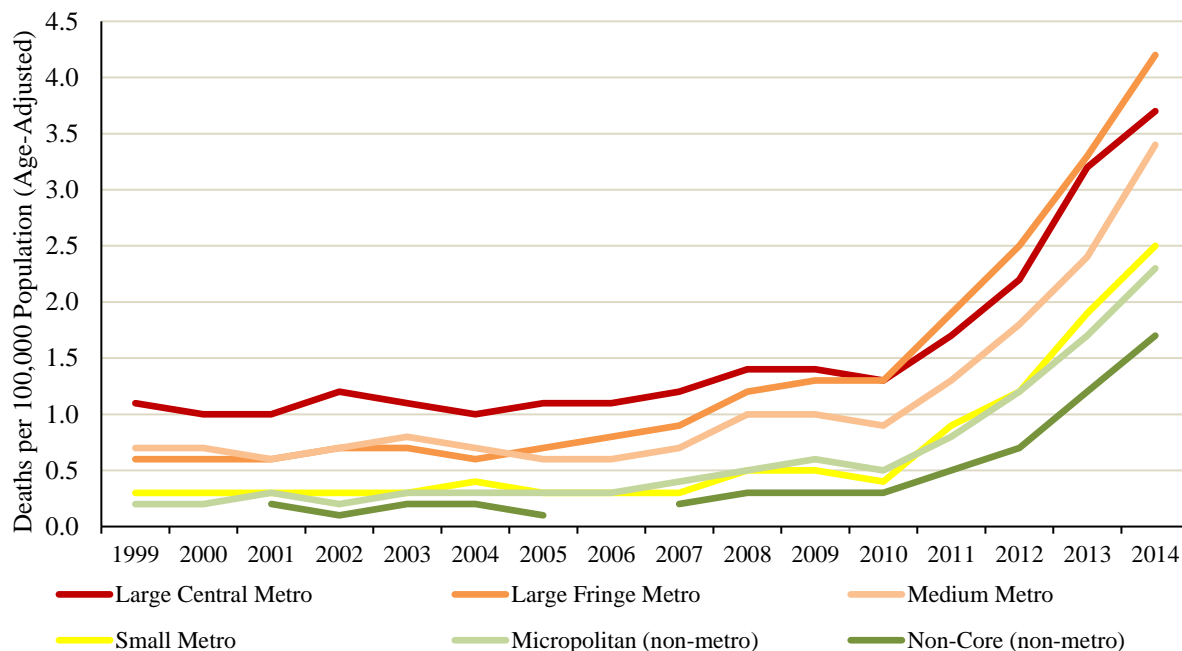
Figure 2. Opioid-Related Inpatient Stays by Patient Location, 2007-2014

Figures 3 and 4 show national trends in drug-poisoning deaths involving PPR and heroin disaggregated by level of urbanization. Figure 3 shows the trends in drug poisoning deaths involving PPR. The data show that, except for large central counties which experienced less than a fifty percent increase (46%), counties across the United States experienced between a three and six-fold increase in the number of drug poisoning deaths related to POA. Non-core counties experienced the largest increase (542%) in drug-poisoning deaths from 1.2 to 7.7 deaths per 100,000. Figure 4 shows that drug poisoning deaths involving heroin rose sharply across all levels of urbanization in the past five years, though non-core counties consistently had lower rates of heroin-involved drug poisoning deaths compared to more urbanized counties (0.1 to 1.7 deaths per 100,000).



Source: Centers for Disease Control and Prevention/National Center for Health Statistics. *Multiple Cause of Death 1999-2013* on CDC WONDER Online Database, released 2015. Extracted by ONDCP on January 26, 2016.

Figure 3. Drug Poisoning Death Rates Involving Opioid Analgesics by Level of Urbanization, 1999 – 2014 (Includes ICD-10 Codes T40.2 to T40.4 and T40.6)



Source: Centers for Disease Control and Prevention/National Center for Health Statistics. *Multiple Cause of Death 1999-2013* on CDC WONDER Online Database, released 2015. Extracted by ONDCP on January 26, 2016.

Figure 4. Drug Poisoning Death Rates Involving Heroin by Level of Urbanization, 1999-2014 (Includes ICD-10 Codes T40.0 and T40.1 and includes Opium)

Discussion

This study found that PPR use has declined and heroin use has increased nationally during the period 2002-2014, except in non-metro areas, where rates in 2014 were similar to rates in 2002. This may indicate an absence of any significant market for heroin in rural communities. Although the level of PPR and heroin use is not substantially different for rural and urban areas, the consequences of drug use in terms of morbidity and mortality tended to be larger in smaller metropolitan and rural areas. Smaller and very rural communities have many fewer resources and are at a distinct disadvantage in terms of providing access to comprehensive and high-quality prevention and treatment services. Substance use disorders are often complex health conditions that can include co-morbid health, mental health, and social issues. Rural counties experience comparatively low educational achievement, low employment and underemployment, high poverty, and access challenges in terms of geographic isolation, and high levels of stigma in terms of accessing health care. Rural counties also are likely to experience significant stressors on public health and public safety systems as a result of higher rates of motor vehicle crashes, sexually transmitted diseases and blood borne viruses such as hepatitis C, fetal alcohol syndrome.

These findings underline an urgent need to expand services in rural communities to address resource limitations. This includes expanding the number of physicians with DATA 2000 waivers, and developing and deploying a well-trained and culturally competent workforce

with specific skills in treating opioid use disorders. One strategy used in the past is to integrate medical practitioners and social workers with treatment expertise into Federally Qualified Health Centers (Corso & Townley, 2016). Another strategy utilized in other high need areas is to use loan repayment programs to incentivizing practitioners to join the National Health Service Corps and long-term deployment of United States Public Health Officers. Expanding these programs into rural community health centers could rapidly expand capacity in rural counties.

State and local governments also may want to invest in tele- and video-health technologies that may serve as a bridge to treatment where no facilities exist (Gates & Alberta, 2016; Rooke, Gates, Norberg, & Copeland, 2014). Expanded use of technology also may address the stigma that exists in rural communities where confidentiality is limited and practitioners may be challenged to maintain the boundary between professional practice and being a member of the community (Brems, Johnson, Warner & Roberts, 2006; Humble, Lewis, Scott, & Herzog, 2013). Additionally, building formal and informal structures for consultation such as Project ECHO where physicians and social workers can connect to specialists to support and advance their practice and improve service access (Brems, Johnson, Warner & Roberts, 2006; Humble, Lewis, Scott, & Herzog, 2013; Corso & Townley, 2016) and may help address, in part, the structural barriers to enhanced training for rural social work practitioners.

Expanding telehealth and teleconsultation services may address some of the need in rural areas. It is not, however, a panacea for the lack of services that are local and culturally relevant in terms of norms, communication styles, and values. Research by Oser and Harp (2015) found that when clients received treatment in a socio-cultural context unfamiliar to them due to lack of access to local care, geographic discordance, they were more likely to experience relapse and incarceration and less likely to be attending 12-step support groups or to have received referrals for continued care in their home community. Given the documented costs to the individual and the community of relapse and continued drug use, the failure to allocate resources to expand treatment in geographically isolated areas appears short-sighted.

This analysis is subject to a number of limitations and thus, care should be taken when interpreting findings. First, the data in this study draw from a number of different data systems and data are not always reported for the same year time span, though there is overlap across significant periods of time. For example, data on drug poisoning deaths cover the years 1999 to 2014 while data on drug use cover the years 2002 to 2014. Second, data that permits comparison by levels of urbanization are scarce and often use different strategies for identifying level of urbanization. In the present study, data from NSDUH utilize Beale codes for classifying level of urbanization while estimates for treatment services, hospital visits, and drug overdose deaths related to PPR and heroin are consistent with NCHS's classification of urban and rural counties. Nevertheless, there is significant similarity across each of these continuums.

Third, self-reported data such as NSDUH depend upon the veracity and accuracy of the individual respondent, which may lead to under or over-reporting of use. The NSDUH utilizes a variety of methods to increase the accuracy of self-reported behavior, including the use of audio computer-assisted self-interviews and confidentiality agreements with respondents (Gfroerer, Everman, & Chromy, 2002). Fourth, NSDUH does not include institutionalized populations such as those found in prisons, jails, treatment facilities, or individuals who are homeless. It also

does not capture active duty military. Consequently, our estimates of past-year users of PPR and heroin may not be generalizable to some segments of the U.S. population and the true number of users and their impact urban and rural counties may be different from the numbers presented in our study.

Finally, the NEDS contains event-level records and there are no unique patient identifiers. Individuals who visit an ED more than one time a year may be counted multiple times in NEDS. Thus, the rate of ED visits may over-represent individuals who are more likely to have adverse consequences to opioid use. Fourteen percent of the records are missing ED charges because there was no ED admission. This leads to undercounting of opioid-related ED visits, regardless of level of urbanization (AHRQ, 2017a). Finally, variability in reporting of specific drugs involved in drug-poisoning deaths may vary by state or jurisdiction, and poly-substance use among decedents precludes drawing conclusion from information based on single drugs or drug subsets.

Even with these limitations, arraying the available information on ED, inpatient, and drug poisoning death rates by level of urbanization provides valuable insight into what rural areas might be experiencing compared with more urbanized communities. Despite relatively comparable levels of PPR use and markedly lower levels of heroin use, rural and less urbanized communities experience disproportionate consequences in terms of emergency and inpatient services use and drug poisoning deaths. The disparity in service availability to treat opioid use disorders point to a need for expanding prevention programming, access to addiction professionals and medication-assisted treatment, including office-based providers, in more rural communities. There are currently a number of efforts underway to increase training for prescribers in the use evidence-based screening and assessment practices and the use of prescription opioid analgesics, alternative pain management strategies, and the use of databases to review patient history prior to prescribing controlled substances (CDC, 2013); Franklin et al., 2015; ONDCP, 2011). Expanding these efforts into semi-rural and rural communities can provide additional tools to identify and support patients who are at-risk for or who have an opioid substance use disorder. Taking into account the unique challenges experienced by rural and less urbanized communities may serve to decrease the disparate consequences of the opioid epidemic found in this study.

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