



Differences in the attitudes towards the opioid crisis between metropolitan and rural counties in Central Texas: Secondary data analysis using cross-sectional data

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ABSTRACT

This study examined metropolitan and rural differences regarding concerns about opioid misuse and support for different strategies to reduce opioid use disorder risk in areas not designated as high-risk. This study used cross-sectional data from a regional community health assessment, which was collected in 2019 using a combination of stratified random sampling and clinic-based purposive sampling in Central Texas. The secondary data included 430 and 270 respondents from metropolitan and rural (not metropolitan) counties, respectively. The primary outcomes were perceived concern about the opioid crisis, perceived likelihood of getting addiction treatment, and support for strategies to reduce opioid use disorder risks. Multiple multivariable regression models were used to examine metropolitan and rural differences in the outcome variables after adjusting for age, sex, ethnicity, race, marital status, education, and household income. Respondents were about 58 years old on average. A majority were female (60%), non-Hispanic (88%), and White (83%). About 60% of rural and metropolitan respondents were concerned about opioid use and misuse in their community. After adjusting for respondents' demographic characteristics, rural respondents were significantly less likely to perceive that individuals are getting the needed opioid use disorder treatment (aOR = 0.69, $P = 0.031$). Rural respondents were also significantly less supportive for legalizing syringe service programs in their communities (aOR = 0.71, $P = 0.044$) than metropolitan respondents. Differing attitudes by respondents from metropolitan and rural areas indicate the importance of tailoring prevention and mitigation efforts to address opioid use disorder in advance of an impending public health crisis.

1. Introduction

The opioid crisis has rippled across America, with devastating public health impacts. (Institute, 2021) While there was some decline in overall opioid-related overdose deaths from 2017 to 2018, rates involving synthetic opioids (e.g., fentanyl) are still increasing. (Hedegaard et al., 2020; Wilson et al., 2020) Nearly 190 people died daily from opioid overdoses in 2020 in the United States, (Ahmad and Rossen, 2021) and

this estimate is possibly underestimated due to incomplete data currently. Declared as a national public health emergency, (US Department of Health Human Services, 2017) the total economic burden on the US economy in 2019 was estimated at \$188 billion, with a range of \$172 billion to \$214 billion. (Davenport et al., 2019).

Recently, opioid drug misuse has increased across rural and urban regions of the United States. (Centers for Disease Control and Prevention., 2018; Centers for Disease Control and Prevention, 2019; Rigg and

Abbreviations: OUD, opioid use disorder; PDMP, prescription drug monitoring program.

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Monnat, 2015; Rigg et al., 2018; Cicero et al., 2007; Hedegaard et al., 2017; Kiang et al., 2019) However, there have been some mixed findings about how the opioid crisis differs in rural and urban regions. (Rigg and Monnat, 2015; Cicero et al., 2007; Hedegaard and Spencer, 2021; Peters et al., 2019) An examination of the National Vital Statistics System (NVSS) showed higher opioid overdose death rates involving synthetic opioids other than methadone in urban counties than in rural counties (2015–2019). (Hedegaard and Spencer, 2021) In another study, estimated opioid overdose deaths from synthetic and multiple opioids were highest in large metro and micro areas, slightly lower in small metro and semi-rural places, and lowest in completely rural areas in 2011–2016. (Peters et al., 2019) National-level comparison between rural and urban areas could conceal potential variations across and within sub-geographic units. (Rigg et al., 2018) Geographic heterogeneity in the accuracy and reliability of drug-related death data can potentially depress official reports of the magnitude of opioid-related problem in some areas. (Ruhm, 2017) Texas is potentially one such area with underreporting of opioid-related deaths due to the high number of counties without a medical examiner. (Karacoostas, 2017) With data particularly scarce to inform preventive or risk mitigation efforts in Texas, more research on understanding variations in geographical and sociodemographic patterns are needed. (Kiang et al., 2019; Hernandez et al., 2020).

Relatively, little attention has been paid to understanding community perspectives in areas less impacted by the opioid crisis, but if overlooked could potentially be future hotspots. Furthermore, there has been rapidly changing opioid overdose trends in urban and rural areas for the past decades. (Hedegaard and Spencer, 2021; Peters et al., 2019) Thus, the primary objective of this study was to explore metropolitan and rural differences in concerns about opioids and support for different strategies to reduce opioid use disorder (OUD) risk in a geographic region currently seen as a non-high risk area in terms of low occurrence of opioid-related fatal overdoses. Of particular interest is examining metropolitan-rural differences in awareness of individuals affected by opioid use in the community; concerns about the opioid crisis; perceived likelihood of getting substance use disorder treatment; and support for various harm reduction strategies. Harm reduction strategies included drug disposal locations, overdose reversal kits (naloxone), legal injection sites, and syringe service programs.

2. Methods

2.1. Data source

This study examined cross-sectional data from the Brazos Valley Regional Health Assessment household survey, a community survey administered approximately every three years since 2002. (Center for Community Health Development, 2019) The 2019 survey data were collected using a combination of stratified random sampling and purposive sampling in eight counties in Central Texas. Designed as a representative sample of the Brazos Valley, its design allows for comparisons between Brazos County and the other more rural counties in the region, and greater representation of under-represented groups, especially minorities and younger adults. A dual-frame sampling methodology was employed with first stratifying the sample to assure representation from the smaller, rural counties. Cell and landline numbers were purchased from a market research firm ($n = 13,863$). The final sample excluded invalid phone numbers (e.g., repeatedly reaching an answering machine or voicemail or disconnected), numbers associated with businesses, respondents under 18 years old or living outside the study area. The final sample ($n = 2,467$) included about 18% of the purchased phone numbers, and 640 completed the survey (25.9% response rate). An additional convenience sample ($n = 123$) was recruited in-person in the waiting rooms of local health-related organizations, primarily serving minority populations or populations with a low socioeconomic status. Given mobile phone users comprised the

population sample, the additional recruitment was conducted to better represent minority and low-income populations. Research documents mobile device use in low-income populations as dependably unstable where low-income users expect periodic disconnection from their devices. (Marler, 2018; Gonzales, 2014) The targeted sample size of 700 was established based on the assessment budget through negotiation with the local survey administration firm. The secondary data analysis of the de-identified data was determined as not human subject research by the Texas A&M University Institutional Review Board (IRB2018-1113).

2.2. Study population

Eligible respondents were community-dwelling residents who were 18 years or older, lived in Austin, Brazos, Burleson, Grimes, Leon, Madison, Robertson, or Washington county in Central Texas, and spoke, read, and wrote English or Spanish at the 7th grade level. Using the Office of Rural Health Policy's determination of rural counties (e.g., micropolitan counties and counties that were not classified as metropolitan area), (Health Resources and Services Administration, 2018) the eight counties were classified into three metropolitan counties ($n = 430$) and five rural counties ($n = 270$).

2.3. Variables

The community survey was developed by a Survey Development Advisory Committee composed of 23 local organizations (health, community, and other volunteer organizations, government and health departments, and educational institutions). The survey, available in English and Spanish, included health-related information, medical history, accessibility to and utilization of health and community services, and sociodemographic information.

This study used the opioid module of the community survey, in which opioids were described as "prescription drugs for pain relief or illicit forms such as heroin and fentanyl taken to get high." Respondents were asked how many people they knew in their community who were misusing (i.e., addiction, sharing, or illicit using) opioids to assess their personal connection with opioid misuse. The variable was dichotomized into knowing 'none' versus 'one or more' persons misusing opioids. The primary outcome variables were perceived concern about the opioid crisis in their community ("how concerned are you about the use/misuse of opioids in your community? – very concerned, concerned, not concerned, or not at all concerned"), perceived likelihood of people getting OUD treatment ("If someone needs treatment for opioid use disorder, how likely do you think it is they are to get the treatment they need? – very likely, likely, not likely, or not at all likely"), and support for strategies to reduce OUD risks. Respondents were asked how much they agreed with and supported policies such as: (1) creating safe disposal locations for old/unused drugs; (2) providing overdose reversal kits (naloxone) to non-medical personnel; (3) creating legal, safe injection sites in your community; and (4) making syringe service programs in your community legal. The response categories were grouped into: strongly support or support, neither support nor oppose, and oppose or strongly oppose.

Assessed sociodemographic characteristics included age (in years), sex, ethnicity, race, marital status, years of education, and total pre-tax household income. If a respondent refused to answer the income question, they were provided with a table of the 2018 Federal poverty level (FPL) guidelines per household size and were asked to indicate whether their household's total income was above or below the poverty level for their household size. In this study, the binary variable indicating household income < 100% FPL and household income at 100% or higher than 100% FPL.

2.4. Statistical analyses

Statistical analyses were performed using SAS 9.4. Mean and

standard deviation or frequency and percentage were used to describe the sociodemographic characteristics and opioids crisis perceptions. Independent group *t*-test and chi-square test were used to assess differences in sociodemographic characteristics and opioid crisis-related awareness and perceptions between metropolitan and rural respondents. Score test and frequency tables were used to determine whether the differences by county of residence (metropolitan vs. rural) were similar for all levels of ordinal primary outcomes (i.e., proportional odds assumption). The proportional odds assumption held valid for all the primary outcome variables. Multivariable ordered logistic regression models were used to assess differences in opioid crisis-related perceptions among metropolitan and rural respondents. All ordinal logistic regression models were adjusted for age, sex, ethnicity, race, marital status, education, and household income. Significance level of 0.05 was used. The multivariable order logistic regression models were repeated among the random sample to assess the consistency of the observed relationship between the outcomes and place of residence.

3. Results

3.1. Study respondents

Of 763 survey responses collected, 700 survey responses were included in this study after eliminating 63 incomplete responses. On average, the respondents from metropolitan counties were significantly younger (55.4 years vs. 61.9 years) than those from rural counties (Table 1). Also, a greater percentage of respondents from metropolitan counties were male (43.4% vs. 35.8%), non-White (20.4% vs. 12.6%), and had higher educational attainment (e.g., 27.6% vs. 15.0% completed at least 17 years of education). In both metropolitan and rural counties, the majority were non-Hispanic (85.8% and 90.3%), married (66.9% and 64.3%), and had household income of 100% federal of the poverty level (using 2018 standards) or higher (89.5% and 89.0%).

Table 1
Sociodemographic Characteristics of the Respondents by Place of Residence.

Characteristics	No. (%) or Mean (SD)		P
	Metropolitan counties (n = 430)	Rural counties (n = 270)	
Age, mean (SD), years	55.4 (17.19)	61.9 (16.06)	<0.001**
Sex, No. (%)			0.047*
Male	185 (43.4%)	96 (35.8%)	
Female	241 (56.6%)	172 (64.2%)	
Ethnicity, No. (%)			0.08
Non-Hispanic	368 (85.8%)	241 (90.3%)	
Hispanic	61 (14.2%)	26 (9.7%)	
Race, No. (%)			0.009*
Non-White	86 (20.4%)	33 (12.6%)	
White	336 (79.6%)	229 (87.4%)	
Marital status, No. (%)			0.48
Not married	142 (33.1%)	96 (35.7%)	
Married	287 (66.9%)	173 (64.3%)	
Years of education, No. (%)			<0.001**
12 years or less	85 (19.9%)	72 (27.0%)	
13 – 16 years	225 (52.6%)	155 (58.1%)	
17 years or more	118 (27.6%)	40 (15.0%)	
Household income, No. (%)			0.86
<100% FPL	40 (10.5%)	26 (11.0%)	
100% FPL or higher	340 (89.5%)	211 (89.0%)	

* *p* < 0.05; ** *p* < 0.001; FPL = federal poverty level; OUD = Opioid use disorder.

3.2. Opioid crisis-related awareness and attitudes

Approximately 20% of respondents reported knowing one or more persons misusing opioids (20.9% and 18.1% for metropolitan and rural, respectively, *P* = 0.38) (Table 2). The majority of the respondents from both metropolitan and rural counties reported they were “concerned” or “very concerned” about the opioid crisis in their community (58.2% and 60.3%, respectively). Both groups also perceived a low likelihood of affected individuals getting OUD treatment (69.4% and 72.6%, respectively), and were supportive of creating safe drug disposal locations (87.0% and 84.0%, respectively).

The respondents from metropolitan counties were significantly more likely to support providing opioid overdose reversal kits to non-medical personnel than those from rural counties (61.4% vs. 50.8%). While less overall support, the respondents from metropolitan counties were also significantly more supportive of legalizing syringe service programs than counterparts from rural counties (28.8% vs. 22.4%). There was slightly more support for creating legal injection sites in the community (36.4% of metropolitan respondents vs. 30.5% of rural residents were supportive), but these geographic differences were not statistically different. About one-quarter of the respondents were neither supportive nor against these three OUD risk reduction strategies.

Table 2
Opioids Crisis-Related Awareness and Attitudes by Place of Residence.

	No. (%)		P
	Metropolitan counties (n = 430)	Rural counties (n = 270)	
Awareness			
Knowing one or more persons misusing opioids	84 (20.9%)	44 (18.1%)	0.38
Attitudes			
Concerns about the opioid crisis			0.61
Very concerned	83 (19.8%)	47 (17.9%)	
Concerned	161 (38.4%)	111 (42.4%)	
Not concerned	123 (29.4%)	68 (26.0%)	
Not at all concerned	52 (12.4%)	36 (13.7%)	
Perceived likelihood of people getting addiction treatment			0.27
Very likely	29 (7.3%)	19 (7.8%)	
Likely	93 (23.3%)	48 (19.6%)	
Not likely	215 (53.9%)	126 (51.4%)	
Not at all likely	62 (15.5%)	52 (21.2%)	
Support for creating safe disposal locations for old/unused drugs			0.31
Oppose	13 (3.1%)	14 (5.3%)	
Neither support nor oppose	42 (9.9%)	28 (10.7%)	
Support	369 (87.0%)	221 (84.0%)	
Support for providing opioid overdose reversal kits (naloxone) to non-medical personnel			0.01*
Oppose	65 (16.0%)	59 (24.2%)	
Neither support nor oppose	92 (22.6%)	61 (25.0%)	
Support	250 (61.4%)	124 (50.8%)	
Support for creating legal, safe injection sites in your community			0.15
Oppose	163 (40.0%)	118 (47.4%)	
Neither support nor oppose	111 (27.3%)	55 (22.1%)	
Support	133 (36.4%)	76 (30.5%)	
Support for making needle exchange programs in your community legal			0.03*
Oppose	186 (45.8%)	143 (56.3%)	
Neither support nor oppose	103 (25.4%)	54 (21.3%)	
Support	117 (28.8%)	57 (22.4%)	

* *P* < 0.05.

3.3. Adjusted differences in opioid crisis-related attitudes by place of residence

After adjusting for respondents' sociodemographic characteristics, respondents from rural counties indicated significantly lower perceived likelihood of affected individuals getting OUD treatment (adjusted odds ratio (aOR) = 0.69, 95% Confidence Interval (CI) = [0.49, 0.97], $P = 0.031$) than those from metropolitan counties (Table 3). Compared to those from metropolitan counties, respondents from rural counties had significantly less support for legalizing syringe service programs in their communities (aOR = 0.71, 95% CI = [0.51, 0.99], $P = 0.044$). No statistically significant difference in other opioid crisis-related attitudes by place of residence were observed.

3.4. Sensitivity analysis

Compared to the random sample, the convenience sample was younger (50 vs. 59 years old) and included more females (71.4% vs. 58.3%), Hispanic (32.8% vs. 10.4%), and non-White (34.9% vs. 15.6%). The convenience sample included a greater percentage of persons with 12 or fewer years of education (48.4% vs. 20.0%), having <100% federal poverty level (35.3% vs. 8.5%), and not having a regular place for medical care (7.8% vs. 4.6%). The sub-group analysis among the random sample ($n = 636$) showed results similar to the analysis performed using the complete sample ($n = 700$). After adjusting for random sample respondents' sociodemographic characteristics, random sample

respondents from rural counties indicated significantly lower perceived likelihood of affected individuals getting OUD treatment (aOR) = 0.68, 95% CI = [0.48, 0.97], $P = 0.034$) than those from metropolitan counties. Compared to those from metropolitan counties, respondents from rural counties had significantly less support for legalizing syringe service programs in their communities (aOR = 0.69, 95% CI = [0.49, 0.98], $P = 0.040$). No statistically significant difference in other opioid crisis-related attitudes by place of residence were observed. For the regression coefficients for the place of residence, the statistical significance and direction remained the same, and the magnitudes remained similar to the original analysis.

4. Discussion

About one-in-five reported knowing someone misusing opioids in their communities. Yet, less than ten opioid-related death cases were reported in the study region 2012–2016. (Texas Department of State Health Services, 2020) The discrepancy could be associated with the local contexts in Texas (low number of medical examiners and lack of Good Samaritans Law) that may contribute to the underreporting of opioid overdose cases. Lack of standardized mortality reporting between and within states (Rigg et al., 2018) and the OUD-associated stigma may have depressed the recognition and reporting of overdose deaths. (Ruhm, 2017) Additionally, overdose deaths are only part of the larger problem. (Salmond and Allread, 2019) Combined with the rippling effects of OUD throughout families and communities, (Brundage and

Table 3
Multivariable Ordered Logistic Regression Analyses Outcome.

	Adjusted Odds Ratio [95% Confidence Interval]					
	Concerns about the opioid crisis	Perceived likelihood of people getting addiction treatment	Support for creating safe disposal locations for old/unused drugs	Support for providing opioid overdose reversal kits (naloxone) to non-medical personnel	Support for creating legal, safe injection sites in your community	Support for making needle exchange programs in your community legal
Place of residence						
Metropolitan	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
Rural	0.80 [0.58, 1.09]	0.69 [0.49, 0.97]*	0.78 [0.46, 1.31]	0.75 [0.53, 1.07]	0.86 [0.61, 1.21]	0.71 [0.51, 0.99]*
Age range (years)	1.02 [1.01, 1.03]**	1.02 [1.01, 1.03]**	1.02 [1.01, 1.04]*	0.99 [0.98, 0.998]*	0.99 [0.98, 1.001]	0.99 [0.98, 0.996]*
Sex						
Male	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
Female	1.19 [0.87, 1.62]	0.75 [0.54, 1.04]	1.99 [1.21, 3.27]*	1.03 [0.73, 1.45]	1.12 [0.81, 1.56]	1.12 [0.81, 1.55]
Ethnicity						
Non-Hispanic	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
Hispanic	0.65 [0.39, 1.08]	2.76 [1.60, 4.75]**	0.70 [0.34, 1.45]	0.92 [0.52, 1.64]	1.79 [1.03, 3.11]*	0.88 [0.52, 1.50]
Race						
Non-White	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
White	1.05 [0.69, 1.60]	1.22 [0.78, 1.92]	0.66 [0.32, 1.35]	0.86 [0.53, 1.39]	0.49 [0.31, 0.76]*	0.89 [0.57, 1.38]
Marital status						
Not married	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
Married	0.77 [0.56, 1.06]	1.07 [0.76, 1.51]	0.73 [0.42, 1.27]	0.57 [0.39, 0.83]*	0.73 [0.52, 1.03]	0.92 [0.65, 1.29]
Years of education						
12 years or less	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
13 – 16 years	0.67 [0.45, 1.01]	1.27 [0.82, 1.97]	1.72 [0.93, 3.17]	0.97 [0.62, 1.53]	0.67 [0.43, 1.03]	1.04 [0.68, 1.59]
17 years or more	0.63 [0.39, 1.01]	1.56 [0.94, 2.58]	2.27 [1.06, 4.86]*	1.47 [0.87, 2.51]	0.73 [0.44, 1.20]	1.47 [0.90, 2.42]
Household income						
<100% FPL	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
100% FPL or higher	1.13 [0.68, 1.90]	1.47 [0.85, 2.55]	1.07 [0.48, 2.41]	1.16 [0.65, 2.05]	0.31 [0.18, 0.56]**	0.83 [0.49, 1.41]

* $P < 0.05$; ** $P < 0.001$.

Levine, 2019) the present study raises potential needs for scrutinizing magnitude and trend of local opioid-related concerns, even in areas with lower opioid-related deaths rates.

Both metropolitan and rural respondents in areas with low opioid-related deaths rates shared similar opioid crisis-related attitudes. For both metropolitan and rural respondents, the majority were concerned about opioid crisis. This response is comparable to the national polls showing 54% regarding addiction to prescription medication as a 'major problem' or 'emergency' in their community. (Blendon and Benson, 2018) In 2018 NORC Center for Public Affairs Research survey, both prescription opioid (43%) and heroin (37%) were reported as a major issue in the community. (NORC, 2018) Other more recent studies confirm opioid use as a major concern in rural areas, (Findling et al., 2020) as well as in more urban areas. (Sealfon et al., 2019).

Similarly, the majority supported having drug disposal sites. This is consistent with the growing awareness of prescription drug take back programs, (e.g. National Prescription Drug Take Back Day). (Diversion Control Division, 2020; Drug Take Back, 2020) Alone in Texas, 32,808 kg of prescription medications were collected on October 26, 2019 and 446,838 kg over the past 18 National Prescription Drug Take Back Days. (Diversion Control Division, 2020) Drug take back programs can also promote conversation about prescription drug disposal. (Yanovitzky, 2016) Yet, the magnitude of program impact on the reduction in prescription medications for potential misuse has been questioned (Egan et al., 2017) and is most appropriately seen as a strategy in a broader armamentarium against drug misuse.

In line with general concerns about access to care in rural areas, (Hub, 2019) the rural respondents perceived lower likelihood of getting OUD treatment among individuals who need it. Yet, rural residents also tended to be less supportive of most OUD risk mitigation strategies. While little is known about the OUD treatment in these rural communities, this has been a growing area of research and relatively low utilization of substance use disorder care in rural areas have been documented in previous literature. (Davis et al., 2016) Additionally, there was general support for, and less opposition to, providing opioid overdose reversal kits (naloxone) to non-medical personnel by both metropolitan and rural respondents. This may reflect the Surgeon General's Advisory on Naloxone and Opioid Overdose and the "Be Prepared. Get Naloxone. Save a Life" campaign. (Office of the Surgeon General, 2018) This may also show the evolution in support from 2017 when the public was much more divided about obtaining naloxone without a prescription (45% in favor and 52% in opposition). (Blendon and Benson, 2018).

There was a lack of community-wide support for injection sites and syringe service programs. This is comparable to the 2017 national survey (28.9% supported injection sites; 39.3% supported syringe service programs). (McGinty et al., 2018) Community resistance can be associated with concern about unintended consequences. (Cook and Worcman, 2019; Wenger et al., 2011) Observed metro-rural difference may be associated with stigma related to substance misuse and less familiarity with the harm reduction strategies (McGinty et al., 2018; Cook and Worcman, 2019; Kulesza et al., 2015) can be possibly due to low accessibility to mental and behavioral health care services in rural areas. (Hub, 2019; Hancock et al., 2017).

While associations of control variables with opioid-related attitudes were not interpreted in the results section, it would be illuminating to further scrutinize the associations. For example, older age was associated with greater concern, greater perceived likelihood of getting needed opioid addiction treatment, greater support for creating drug disposal locations, less support for controversial OUD risk mitigation strategies (naloxone distribution and needle exchange programs). These results are consistent with the growing recognition of the impact of the opioid epidemic on middle-aged and older adults (Perlman, 2019) and their relatively conservative views. (Foundation, 0000) Attitudes related to opioid use and risk mitigation strategies were also associated with other demographic characteristics. These findings may be linked to prior

associations with opioid use patterns, (Han et al., 2017; Haider et al., 2020) health-seeking behaviors, familiarity with those with an opioid use problem, awareness of potential risks associated with drug misuse, and attitudes toward harm reduction strategies. (Health, 2017) However, single models used in this study can be insufficient to examine the sociodemographic differences, and interpretation of regression coefficients for control variables using single models should be viewed cautiously. (Keele et al., 2019; Westreich and Greenland, 2013).

4.1. Recommendations for future action

Communities must recognize that they have a stake in combatting the opioid epidemic and that proactive actions can have positive results. (Cyril et al., 2015) Based on our study findings and previous works in this emergent area, we recommend a comprehensive multi-sectorial approach, drawing upon strategies that have already shown preliminary success in other communities across the nation:

1. Increase access to the full range of OUD treatment modalities. (Substance Abuse and Mental Health Services Administration. Medication-assisted treatment (MAT), 2020) Providing education and support to clinicians to increase the number of DEA Data 2000 or "X-Waivers" in the community which allows clinicians (e.g., physicians, physician assistants, nurse practitioners, clinical nurse specialists, certified registered nurse anesthetists, and certified nurse midwives) to prescribe buprenorphine, a key therapy to encourage meaningful recovery from OUD, is critical to improving outcomes. Educational efforts aimed at doctors and substance use disorder treatment providers are recommended to introduce the full range of treatments, including medication assisted treatment and harm reduction initiatives.
2. Develop ordinances and sites for safe drug disposal. (Drug Enforcement Administration, 2020) Having a consistent and easily accessible safe drug disposal site that can increase the pounds of unwanted prescription medication that are collected, diverting misuse from at risk populations (e.g., children and adolescents) and decreasing presence in water supplies and landfills. Additionally, it is important to have places where illicit drugs can also be dropped off safely and securely.
3. Provide intranasal naloxone training for all willing persons. (Office of the Surgeon General, 2018) Provisioning trained individuals with a naloxone rescue kit, if state permit, can encourage use. Intranasal transmission is easy to use, and coupling with training to include a short overdose simulation can increase the confidence of trainees. The training may include topics such as stigma related to the use of naloxone and Good Samaritan Laws to encourage individuals to intervene during a suspected overdose event without fear of repercussions in the case of a negative outcome.
4. Reduce stigma about and stand up more syringe service programs. (McGinty et al., 2018) These programs provide access to clean and sterile equipment to reduce contamination in the preparation and consumption of drugs, and hence reduce overdose morbidities and mortality. Ancillary services can be provided for the prevention and reversal of opioid overdose, such as naloxone training and distribution and fentanyl testing strips. Furthermore, such programs can also provide additional social and medical services important for jump starting recovery efforts including referral and access to drug treatment programs as well as other needed medical, mental health, and social services.

While community coalition or the state's prescription drug monitoring program (PDMP) were not examined in the current study, previous works (Big Cities, 2020; Hub, 2019; Centers for Disease Control and Prevention, 2020) show the importance of including those as a part of the comprehensive approach.

4.2. Limitation

These analyses were based in one geographic area of Texas and may not be generalizable to other areas state- or nation-wide. Similar to the Texas and national demographics, the current study showed a greater proportion of individuals with older age, non-Hispanic and White background, and fewer years of education. (Rural Health, 2021) Compared to the Texas or national rates, the current study included a higher proportion of older adults (e.g., 49% in the current study population from rural areas vs. 19% and 18% in US and Texas rural areas) and females (e.g., 64% in the current study population from rural areas vs. 50% and 51% in US and Texas rural areas). (Rural Health, 0000) Although using the Office of Rural Health Policy's classification of metropolitan and rural areas, (Health Resources and Services Administration, 2018) there were variations in size in the rural areas and the metropolitan areas were better classified as small metropolitan or peri-urban areas versus large metro areas. The selected areas are non-high risk areas, and beliefs of residents in this area can be different from beliefs of residents in high risk areas. Additionally, the response rate was relatively low (~25%), yet typical of average rates for community surveys. (National Research Center, 2016) Familiarity with the communities and marketing the survey through community partnerships enabled this response rate. As the goal of the larger initiative was to describe opioid-related use and attitudes, not to examine metro-rural variations, we did not use sample weights. Lastly, for some of the adjusted odds ratio for the place of residence, the upper or lower 95% confidence interval was close to the null value. We acknowledge low power for some estimates and recommend further study with a larger and more representative sample size that can address the limitations stated above and improve the statistical power.

5. Conclusion

This study has provided the granularity to inform further community-based investigation and initiatives by examining metropolitan/rural differences in perceptions towards opioids crisis and harm reduction strategies. (Schoenfeld et al., 2019) Understanding community awareness and attitudes towards the opioid crisis and potential harm reduction strategies can provide valuable insights to local policymakers and public health practitioners attempting to address the problem. With the opioid epidemic rapidly evolving, additional research on temporal patterns of the epidemic and attitudes among a broader population, which include both high and non-high risk urban and rural areas, is recommended.

CRedit authorship contribution statement

Marcia G. Ory: Conceptualization, Methodology, Resources, Supervision, Project administration. **Shinduk Lee:** Conceptualization, Methodology, Formal analysis, Data curation. **Matthew Lee Smith:** Conceptualization, Methodology. **Joy P. Alonzo:** Conceptualization. **Heather R. Clark:** Conceptualization, Methodology, Investigation, Project administration. **James N. Burdine:** Conceptualization, Methodology, Investigation, Resources, Supervision, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

National Institute on Drug Abuse. Opioid overdose crisis. 2021 Feb 25 [cited 25 February 2021]. Available from: <https://www.drugabuse.gov/drug-topics/opioids/opioid-overdose-crisis>.

- Hedegaard, H., Minino, A.M., Warner, M. Drug overdose deaths in the United States, 1999–2018. *NCHS Data Brief*. 2020;(356). Available from: <https://www.cdc.gov/nchs/data/databriefs/db356-h.pdf>.
- Wilson, N., Karisa, M., Seth, P., Smith, H., Davis, N.L., 2020. Drug and Opioid-Involved Overdose Deaths — United States, 2017–2018. *MMWR Morb. Mortal. Wkly. Rep.* 69 (11), 290–297.
- Ahmad, F.B., Rossen, L.M., Sutton, P. 2021 Nov 7 [cited 29 November 2021]. Provisional drug overdose death counts. Available from: <https://www.cdc.gov/nchs/nvss/vsrr/drug-overdose-data.htm>.
- US Department of Health & Human Services. HHS acting secretary declares public health emergency to address national opioid crisis. 2017 October 26 [cited 13 August 2020]. Available from: <https://www.hhs.gov/about/news/2017/10/26/hhs-acting-secretary-declares-public-health-emergency-address-national-opioid-crisis.html>.
- Davenport, S., Weaver, A., Caverly, M. Economic impact of non-medical opioid use in the United States. 2019 [cited 25 February 2021]. Available from <https://www.soa.org/globalassets/assets/files/resources/research-report/2019/econ-impact-non-medical-opioid-use.pdf>.
- Centers for Disease Control and Prevention. 2018 Annual surveillance report of drug-related risks and outcomes – United States. Surveillance Special Report. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. 2018 August 31 [cited 13 August 2020]. Available from: <https://www.cdc.gov/drugoverdose/pdf/pubs/2018-cdc-drug-surveillance-report.pdf>.
- Centers for Disease Control and Prevention. 2019 Annual surveillance report of drug-related risks and outcomes – United States. 2019 November 1 [cited 25 February 2021]. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. Available from: <https://www.cdc.gov/drugoverdose/pdf/pubs/2019-cdc-drug-surveillance-report.pdf>.
- Rigg, K.K., Monnat, S.M., 2015. Urban vs. rural differences in prescription opioid misuse among adults in the United States: Informing region specific drug policies and interventions. *Int. J. Drug Policy*. 26 (5), 484–491. <https://doi.org/10.1016/j.drugpo.2014.10.001>.
- Rigg, K.K., Monnat, S.M., Chavez, M.N., 2018. Opioid-related mortality in rural America: Geographic heterogeneity and intervention strategies. *Int. J. Drug Policy*. 57, 119–129. <https://doi.org/10.1016/j.drugpo.2018.04.011>.
- Cicero, T.J., Surratt, H., Inciardi, J.A., Munoz, A., 2007. Relationship between therapeutic use and abuse of opioid analgesics in rural, suburban, and urban locations in the United States. *Pharmacopidemiol Dr S.* 16 (8), 827–840. <https://doi.org/10.1002/pds.1452>.
- Hedegaard, H., Miniño, A.M., Warner M. Urban-rural differences in drug overdose death rates, by sex, age, and type of drugs involved, 2017. *NCHS Data Brief*. 2019;(345). Available from: <https://www.cdc.gov/nchs/data/databriefs/db345-h.pdf>.
- Kiang, M.V., Basu, S., Chen, J., Alexander, M.J., 2019. Assessment of changes in the geographical distribution of opioid-related mortality across the United States by opioid type, 1999–2016. *JAMA Netw Open*. 2 (2), e190040 <https://doi.org/10.1001/jamanetworkopen.2019.0040>.
- Hedegaard, H., Spencer, M.R. Urban-rural differences in drug overdose death rates, 1999–2019. *NCHS Data Brief*. 2021:403. doi: 10.15620/cdc:10289.
- Peters, D.J., Monnat, S.M., Hochstetler, A.L., Berg, M.T., 2019. The opioid hydra: understanding overdose mortality epidemics and syndemics across the rural-urban continuum. *Rural Soc.* 85 (3), 589–622. <https://doi.org/10.1111/ruso.12307>.
- Ruhm, C.J., 2017. Geographic variation in opioid and heroin involved drug poisoning mortality rates. *Am. J. Prev. Med.* 53 (6), 745–753. <https://doi.org/10.1016/j.amepre.2017.06.009>.
- Karacoastas C. Scale of opioid epidemic in texas likely obscured by bad data, experts say. *The Daily Texan*. 2017 November 17 [cited 13 August 2020]. Available from: <https://thedailytexan.com/2017/11/17/scale-of-opioid-epidemic-in-texas-likely-obscure-d-by-bad-data-experts-say>.
- Hernandez, A., Branscum, A.J., Li, J., MacKinnon, N.J., Hincapie, A.L., Cuadros, D.F., 2020. Epidemiological and geospatial profile of the prescription opioid crisis in Ohio, United States. *Sci. Rep.-UK* 10 (1), 4341. <https://doi.org/10.1038/s41598-020-61281-y>.
- Center for Community Health Development. 2019 Brazos Valley regional health assessment report. [cited 13 August 2020]. Available from: <https://cchd.us/wp-content/uploads/2019/06/2019-BVHSA-Report-FINAL.pdf>. Accessed Aug 13, 2020.
- Marler, W., 2018. Mobile phones and inequality: Findings, trends, and future directions. *New Media & Soc.* 20 (9), 3498–3520. <https://doi.org/10.1177/1461444818765154>.
- Gonzales, A.L., 2014. Health benefits and barriers to cell phone use in low-income urban U.S. neighborhoods: Indications of technology maintenance. *Mobile Media & Commun.* 2 (3), 233–248.
- Health Resources and Services Administration. List of rural counties and designated eligible census tracts in metropolitan counties. 2018 December 31 [cited 13 August 2020]. Available from: <https://www.hrsa.gov/sites/default/files/hrsa/ruralhealth/resources/forhpeligibleareas.pdf>.
- Texas Department of State Health Services. Substance use. [cited 13 August 2020]. Available from: <http://healthdata.dshs.texas.gov/dashboard/drugs-and-alcohol/substance-related-deaths>.
- Salmond, S., Allread, V., 2019. A population health approach to america's opioid epidemic. *Orthop. Nurs.* 38 (2), 95–108. <https://doi.org/10.1097/NOR.0000000000000521>.
- Brundage SC, Levine C. The ripple effect: The impact of the opioid epidemic on children and families. 2019 March [cited 13 August 2020]. Available from: https://uhfnyc.org/media/filer_public/17/2c/172ca968-43aa-45f9-a290-50018e85a9d8/uhf-opioids-20190315.pdf.
- Blendon, R.J., Benson, J.M., 2018. The public and the opioid-abuse epidemic. *New Engl. J. Med.* 378 (5), 407–411. <https://doi.org/10.1056/nejmp1714529>.

- NORC at the University of Chicago. Americans recognize the growing problem of opioid addiction. 2018. Available from: https://apnorc.org/wp-content/uploads/2020/02/APNORC_Opioids_Report_2018.pdf.
- Findling, M.G., Blendon, R.J., Benson, J.M., Sayde, J.M., Miller, C.E., 2020. Views of rural US adults about health and economic concerns. *JAMA Netw. Open.* 3 (1), e1918745 <https://doi.org/10.1001/jamanetworkopen.2019.18745>.
- Sealfon N, Taylor M, Robertson M, et al. Maryland public opinion survey on opioids, 2019. 2019 August [cited 13 August 2020]. Available from: <https://www.pharmacy.umaryland.edu/media/SOP/wwwpharmacyumarylandedu/programs/bhrt/pdf/md-public-opinion-survey-on-opioids-2019.pdf>.
- Diversion Control Division. National Prescription Drug Take Back Day. [cited 13 August 2020]. Available from: https://www.deadiversion.usdoj.gov/drug_disposal/take_back/.
- Drug Take Back - Texas Dose of Reality. Texas Attorney General's Office promotes drug take back programs. [cited 5 July 2020]. Available from: <https://doseofreality.texas.gov/drug-take-back/>.
- Diversion Control Division. DEA National Take Back: 18th National Take Back Day. [cited 13 August 2020]. Available from: <https://takebackday.dea.gov/sites/default/files/NTBI%2018%20Totals.pdf>.
- Yanovitzky, I., 2016. The american medicine chest challenge: Evaluation of a drug take-back and disposal campaign. *J. Stud. Alcohol. Drugs.* 77 (4), 549–555. <https://doi.org/10.15288/jsad.2016.77.549>.
- Egan, K.L., Gregory, E., Sparks, M., Wolfson, M., 2017. From dispensed to disposed: Evaluating the effectiveness of disposal programs through a comparison with prescription drug monitoring program data. *Am. J. Drug Alcohol. Ab.* 43 (1), 69–77. <https://doi.org/10.1080/00952990.2016.1240801>.
- Rural Health Information Hub. Healthcare access in rural communities. 2019 January 18 [cited 13 August 2020]. Available from: <https://www.ruralhealthinfo.org/topics/healthcare-access>. Updated 2019. Accessed Aug 13, 2020.
- Davis, M.M., Spurlock, M., Dulacki, K., Meath, T., Li, H.-F., McCarty, D., Warne, D., Wright, B., McConnell, K.J., 2016. Disparities in alcohol, drug use, and mental health condition prevalence and access to care in rural, isolated, and reservation areas: findings from the South Dakota Health Survey. *J. Rural. Health.* 32 (3), 287–302.
- Office of the Surgeon General. U.S. surgeon general's advisory on naloxone and opioid overdose. 2018 [cited 13 August 2020]. Available from: <https://www.hhs.gov/surgengeneral/priorities/opioids-and-addiction/naloxone-advisory/index.html>.
- McGinty, E.E., Barry, C.L., Stone, E.M., Niederdeppe, J., Kennedy-Hendricks, A., Linden, S., Sherman, S.G., 2018. Public support for safe consumption sites and syringe services programs to combat the opioid epidemic. *Prev Med.* 111, 73–77.
- Cook, A.K., Worcman, N., 2019. Confronting the opioid epidemic: Public opinion toward the expansion of treatment services in Virginia. *Health Justice.* 7 (1), 1–12. <https://doi.org/10.1186/s40352-019-0095-8>.
- Wenger, L.D., Arreola, S.G., Kral, A.H., 2011. The prospect of implementing a safer injection facility in san francisco: Perspectives of community stakeholders. *Int. J. Drug Policy.* 22 (3), 239–241. <https://doi.org/10.1016/j.drugpo.2011.01.001>.
- Kulesza, M., Teachman, B.A., Werntz, A.J., Gasser, M.L., Lindgren, K.P., 2015. Correlates of public support toward federal funding for harm reduction strategies. *Subst. Abuse Treat Pr.* 10 (1), 25. <https://doi.org/10.1186/s13011-015-0022-5>.
- Hancock C, Mennenga H, King N, Andrilla H, Larson E, Schou P. Treating the rural opioid epidemic. 2017 [cited 13 August 2020]. Available from: https://www.ruralhealthweb.org/NRHA/media/Emerge_NRHA/Advocacy/Policy%20documents/Treating-the-Rural-Opioid-Epidemic_Feb-2017_NRHA-Policy-Paper.pdf.
- Perlman WR. Drug use and its consequences increase among middle-aged and older adults. 2019 [cited 13 August 2020]. Available from: <https://www.drugabuse.gov/news-events/nida-notes/2019/07/drug-use-its-consequences-increase-among-middle-aged-older-adults>.
- Foundation for a Healthy Kentucky, Interact for Health. Kentucky adults familiar with needle exchanges more likely to favor them. [cited 13 August 2020]. Available from: <https://www.interactforhealth.org/upl/media/khip-2016-kentucky-adults-familiar-with-needle-exchange-more-likely-to-favor-them.pdf>.
- Han, B., Compton, W.M., Blanco, C., Crane, E., Lee, J., Jones, C.M., 2017. Prescription opioid use, misuse, and use disorders in U.S. adults: 2015 national survey on drug use and health. *Ann. Intern Med.* 167 (5), 293–301. <https://doi.org/10.7326/m17-0865>.
- Haider, M.R., Brown, M.J., Gupta, R.D., Karim, S., Olatosi, B., Li, X., 2020. Psycho-Social Correlates of Opioid Use Disorder among the US Adult Population: Evidence from the National Survey on Drug Use and Health, 2015–2018. *Substance Use & Misuse* 55 (12), 2002–2010.
- CVS Health. Public opinion of prescription drug abuse and disposal. 2017 September [cited 13 August 2020]. Available from: <https://cvshhealth.com/sites/default/files/cvs-health-prescription-drug-abuse-and-disposal-report.pdf>.
- Keele, L., Stevenson, R.T., Elwert, F., 2019. The causal interpretation of estimated associations of regression models. *Political. Sci. Res. Methods.* <https://doi.org/10.1017/psrm.2019.31>.
- Westreich, D., Greenland, S., 2013. The Table 2 Fallacy: Presenting and Interpreting Confounder and Modifier Coefficients. *Am. J. Epidemiol.* 177 (4), 292–298.
- Cyril, S., Smith, B.J., Possamai-Inesedy, A., Renzaho, A.M.N., 2015. Exploring the role of community engagement in improving the health of disadvantaged populations: A systematic review. *Global Health Action.* 8 (1), 29842. <https://doi.org/10.3402/gha.v8.29842>.
- Substance Abuse and Mental Health Services Administration. Medication-assisted treatment (MAT). 2020 August 27 [cited 17 August 2020]. Available from: <https://www.samhsa.gov/medication-assisted-treatment>.
- Drug Enforcement Administration. Take back day. [cited 17 August 2020]. Available from: <https://takebackday.dea.gov/>.
- Big Cities Health Coalition. Opioids misuse and abuse. [cited 17 August 2020]. Available from: <https://www.bigcitieshealth.org/opioids>.
- Rural Health Information Hub. Federal & other national initiatives targeting rural communities. 2019 September 9 [cited 17 August 2020]. Available from: <https://www.ruralhealthinfo.org/topics/opioids#federal-initiatives>.
- Centers for Disease Control and Prevention. Prescription drug monitoring programs (PDMPs). 2020 June 10 [cited 17 August 2020]. Available from: <https://www.cdc.gov/drugoverdose/pdmp/states.html>.
- Rural Health Information Hub. Rural data explorer. [cited 20 May 2021]. Available from: <https://www.ruralhealthinfo.org/data-explorer>.
- National Research Center. What's the average response rate for a citizen survey? 2016 September 23 [cited 17 August 2020]. Available from: <https://www.n-r-c.com/what-s-the-average-response-rate-for-a-citizen-survey/>.
- Schoenfeld, E.R., Leibowitz, G.S., Wang, Y.u., Chen, X., Hou, W., Rashidian, S., Saltz, M. M., Saltz, J.H., Wang, F., 2019. Geographic, temporal, and sociodemographic differences in opioid poisoning. *Am. J. Prev. Med.* 57 (2), 153–164.