Association Between Interorganizational Collaboration in Opioid Response and Treatment Capacity for Opioid Use Disorder in Counties of Five States: A Cross-Sectional Study

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William L Swann[1], Michael DiNardi[2] and Terri L Schreiber[3]

[1]School of Public Affairs, University of Colorado Denver, Denver, CO, USA. [2]Department of Economics, University of Rhode Island, Kingston, RI, USA. [3]CEO/Founder, The Schreiber Research Group, Denver, CO, USA.

ABSTRACT

BACKGROUND: Local governments on the front lines of the opioid epidemic often collaborate across organizations to achieve a more comprehensive opioid response. Collaboration is especially important in rural communities, which can lack capacity for addressing health crises, yet little is known about how local collaboration in opioid response relates to key outputs like treatment capacity.

PURPOSE: This cross-sectional study examined the association between local governments' interorganizational collaboration activity and agonist treatment capacity for opioid use disorder (OUD), and whether this association was stronger for rural than for metropolitan communities.

METHODS: Data on the location of facilities providing buprenorphine and methadone were merged with a 2019 survey of all 358 counties in 5 states (CO, NC, OH, PA, and WA) that inquired about their collaboration activity for opioid response. Regression analysis was used to estimate the effect of a collaboration activity index and its constituent items on the capacity to provide buprenorphine or methadone in a county and whether this differed by urbanicity.

RESULTS: A response rate of 47.8% yielded an analytic sample of n = 171 counties, including 77 metropolitan, 50 micropolitan, and 44 rural counties. Controlling for covariates, a 1-unit increase in the collaboration activity index was associated with 0.155 (95% CI = 0.005, 0.304) more methadone facilities, ie, opioid treatment programs (OTPs), per 100 000 population. An interaction model indicated this association was stronger for rural (average marginal effect = 0.354, 95% CI = 0.110, 0.599) than for non-rural counties. Separate models revealed intergovernmental data and information sharing, formal agreements, and organizational reforms were driving the above associations. Collaboration activity did not vary with the capacity to provide buprenorphine at non-OTP facilities. Spatial models used to account for spatial dependence occurring with OUD treatment capacity showed similar results.

CONCLUSION: Rural communities may be able to leverage collaborations in opioid response to expand treatment capacity through OTPs.

KEYWORDS: Collaboration, opioid use disorder, public health practice, substance use, rural health, opioid treatment programs

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CORRESPONDING AUTHOR: William L Swann, School of Public Affairs, University of Colorado Denver, 1380 Lawrence Street, Suite 500, Denver, CO 80204, USA.
Email: william.swann@ucdenver.edu

Introduction

Drug overdose deaths in the United States were already at an all-time high in 2019 before they surged further during the COVID-19 pandemic. From April 2020 to April 2021, there were about 92 000 US drug overdose deaths, a 31% increase in the age-adjusted drug overdose death rate from the prior year.[1] Over 70% of these deaths involved opioids, most of which were due to synthetic opioids (other than methadone), which increased by 56% over the prior year.[1] Synthetic opioids, which are mostly used illicitly, are extremely potent and deadly. Fentanyl, for example, can be up to 50 times stronger than heroin and 100 times stronger than morphine[2] and can increase the rapidity of an overdose to a matter of minutes or seconds.[3] While thousands still fatally overdose on prescription opioids and heroin every year, synthetic opioids kill over 150 people per day, on average, in the United States alone.[4] Without more substantive policy reform, the Stanford-*Lancet* Commission reported that in addition to the 600 000 opioid deaths that have occurred since 1999, 1.2 million more opioid deaths are expected in North America by 2030.[5]

Expanding access to evidence-based medications for opioid use disorder (MOUD) is paramount to curbing the opioid epidemic.[6] Methadone, buprenorphine, and naltrexone are the MOUD currently approved by the US Food and Drug Administration to treat opioid use disorder (OUD). However, most people with OUD do not receive or have access to MOUD[7,8] and there is less evidence of naltrexone's effectiveness relative to methadone and buprenorphine.[9] Methadone and buprenorphine are full and partial agonist therapies for OUD, respectively, which eliminate or reduce withdrawal symptoms by either fully (methadone) or partially (buprenorphine) binding to and activating the same receptors in the brain as any opioid but do so more slowly without producing euphoria for people with OUD.[10] With sufficient dosage and duration, they are equally effective in treating OUD and reducing the risk of opioid overdose, treatment attrition, and the need for serious acute care,[9-11] but they differ in their regulation, distribution, and accessibility.

Methadone is only available for OUD treatment purposes through federally licensed opioid treatment programs (OTPs). These facilities can operate publicly or privately, offer other forms of MOUD (including buprenorphine and naltrexone), and are often located in metropolitan areas, which limits access for rural residents. For example, as of 2011, 88.6% of the largest non-metropolitan counties lacked a sufficient number of OTPs.[12] Provision of buprenorphine, on the other hand, requires clinicians to obtain an "X waiver" from the US Drug Enforcement Administration and, if treating more than 30 patients at any 1 time, complete specialized training before prescribing in clinical settings (clinicians who treat 30 or fewer patients are exempted from the training as of April 2021).[13] Buprenorphine was permitted under the Drug Addiction Treatment Act of 2000, which aimed to lower barriers associated with OTPs and increase the capacity to treat OUD nationwide. However, enrollment in buprenorphine maintenance therapy remains low and is constrained by uneven geographical distribution, state-level decisions to opt out of Medicaid expansion, and underutilized prescribing capacity, among other barriers.[14] In rural settings, residents have less access to buprenorphine[15] and physicians can experience barriers to prescribing it, namely concerns over diversion, lack of mental health support, time constraints, and financial reimbursement.[16]

While policy reform is needed at all levels of government to expand access to MOUD and other evidence-based practices, local governments and their health departments can play an active role in opioid response implementation.[17,18] Since the opioid epidemic was declared a national emergency in 2017, about two-thirds (65%) of local health departments (LHDs) reported conducting activities to address opioid use and abuse.[19] However, the cross-jurisdictional and cross-sector scale and complexity of the opioid epidemic hinder any government or organization from adequately addressing the problem alone.[20,21] LHDs involved in opioid response, either directly themselves or indirectly through service providers, often collaborate with governmental and nongovernmental partners to address opioid use and overdose.[19,21] This study refers to this behavior generally as interorganizational collaboration, defined as "the pooling of appreciations and/or tangible resources, eg, information, money, labor, etc., by two or more stakeholders, to solve a set of problems which neither can solve individually."[22] The mechanisms of such collaboration are controlled not by markets or hierarchies but rather by "sets of negotiations that are demanded by the lack of predefined institutional roles that accompany market- and authority-based relationships."[23] Such collaboration includes 2 distinct yet complementary facets: cooperation and coordination.[24] Interorganizational cooperation is defined as "joint pursuit of agreed-on goal(s) in a manner corresponding to a shared understanding about contributions and payoffs."[24] Its success or failure is tied to the interests and incentives of actors and their willingness to give up something they have for something they want from a collaboration, the details of which are often delineated in formal (eg, written) or informal (eg, verbal) agreements. Interorganizational coordination is defined as "the deliberate and orderly alignment or adjustment of partners' actions to achieve jointly determined goals," which often involves information-sharing, decision-making, and feedback loops that enable the collaboration to operate efficiently and effectively.[24] Integrating the 2 facets in appropriate and carefully measured ways may prove promising for addressing both relational (cooperation) and administrative-technical (coordination) concerns of interorganizational collaboration.[24]

To date, little is known about the impacts of local-level interorganizational collaborations on tackling, or building community capacity to address, the opioid overdose crisis. These collaborations take on myriad forms and objectives in practice such as sharing data and information between hospital emergency departments (EDs) and LHDs for engaging in opioid response,[25] requiring collaborations between non-profit hospitals and LHDs in local health planning,[26] using interagency collaborations between law enforcement/first responders and health providers to increase treatment referrals,[27] or engaging in cross-municipal collaboration in implementing post-overdose outreach programs operated by public health and safety providers.[28] In some cases, such as in collaborations between EDs and LHDs, joint organizational goals and activities may be more easily aligned around, for example, health and prevention improvement; in other cases, such as in collaborations involving police and public health, goal alignment and achievement can be more challenging with conflicting agendas on drug use that may undermine health outcomes and equity.[29] Rural communities, in particular, have been a key focus of prior research on collaboration in opioid response. Interorganizational collaboration is important in rural areas for pooling resources, aligning expertise, and delivering health services generally[30] but is difficult in rural opioid response when there is little capacity to begin with.[31] Studies suggest cross-sector collaborations involving multidisciplinary professionals and stakeholders can promote progress along key metrics like opioid prescription volumes[32] and community forums can better position rural communities to collaboratively address opioid use.[33] More research is needed to identify collaborative strategies for local communities, especially in rural areas heavily affected by opioid use, and how they relate to the availability of evidenced-based MOUD.

This study aims to determine whether there is an association between local government engagement in interorganizational collaboration activity and the capacity to provide OUD treatment, and whether such engagement matters more for rural communities than their non-rural counterparts. To that end, an index measure of interorganizational collaboration activity was created from responses to a 2019 survey that asked county government and health officials about their organization's engagement in collaboration activity for opioid response and merged with data on the location of facilities providing opioid agonist treatments of either buprenorphine or methadone. Regression analysis was used to estimate the effect of the collaboration activity index, and its constituent items, on the number of buprenorphine or methadone providers per capita in a county and whether this differs by urbanicity.

Methods

Study design and sampling procedures

This cross-sectional study merged data from a 2019 survey of all county governments in 5 states (Colorado, North Carolina, Ohio, Pennsylvania, and Washington) with data on the location of opioid treatment facilities providing buprenorphine or methadone from the Substance Abuse and Mental Health Services Administration (SAMHSA). The 2019 survey purposely selected these states to achieve variation in opioid overdose death rates, political leaning, and geographic region. Of the 5 states before the dissemination of the survey, Washington had the lowest age-adjusted opioid overdose death rate per 100 000 population in 2017 (9.6), whereas Ohio had the highest (39.2) (5-state mean = 20.0).[34] Of these states, Washington had the lowest Republican vote share in the 2016 presidential election (38.1%), and Ohio had the highest (51.7%) (5-state mean = 46.2%). Each state (CO, NC, OH, PA, and WA) was located in a different region of the United States (Mountain West, South, Midwest, North, and West, respectively) to enhance the representativeness of the survey.

Qualtrics (Provo, UT) was used from November 2018 to September 2019 to conduct a Web-based survey of county officials who were asked questions concerning their government's opioid response activities. For each state, respondent email addresses were collected from official county government Websites and prioritized according to likely knowledge about opioid response in their jurisdiction. Email contacts of health directors or substance use managers were sought first since these officials were thought to be the most knowledgeable about opioid response in their local community, followed by county managers or administrators, and then by county commission chairs. Prior to dissemination, the questionnaire was reviewed by 2 physicians with decades of experience working in substance use and addiction medicine. The study was deemed not human subject research by the Colorado Multiple Institutional Review Board.

Independent variable

The focal independent variable, the interorganizational collaboration activity index, was created based on responses to the 2019 survey. With no publicly available dataset on local community collaboration for opioid response existing, a survey was developed and used to collect data on this activity area. Among other questions, the survey asked local government and health officials: "Has your local government engaged in any of the following collaborative actions relating to the opioid crisis prevention and/or intervention? (Check all that apply.)." This question and the 5 interorganizational collaboration actions listed below it were adapted to the community opioid response context from an existing survey instrument used by the corresponding author to study interorganizational collaboration in local government settings in a separate policy area.[35] Theoretical research on self-organizing in metropolitan governance and institutional collective action[36] guided the development of the original survey measure and its adaptation to the opioid response context. The items included actions associated with the coordination (eg, information-sharing and organizational adjustments/reforms) and cooperation (eg, formal and informal interlocal agreements between local government jurisdictions) facets of interorganizational collaboration[24] described above:

- Worked with other agencies or local governments in activities such as sharing data and information on opioid misuse/abuse, treatment, etc.
- Joined a collaborative partnership with other governmental and nongovernmental organizations (eg, regional forum, taskforce)
- Entered into an informal agreement with one or more local governments on opioid-related issues
- Entered into a formal agreement with one or more local governments on opioid-related issues
- Made organizational reforms (eg, consolidating departments, creating new ad hoc committees) based on a collaborative partnership for addressing the opioid crisis

Items were treated as binary indicators and used to create a summative index of interorganizational collaboration activity in community opioid response. This index captured variation across different types (intergovernmental, interagency, and cross-sector) and facets (cooperation and coordination) of interorganizational collaboration. Items were also analyzed separately to determine which individual collaboration actions were associated with either type of OUD treatment capacity.

Dependent variables

Data for the dependent variables were collected from SAMHSA, including the location of facilities providing buprenorphine[37] and location of OTPs providing methadone,[38] current as of February 6, 2022. A facility providing buprenorphine was defined as including at least one practicing waivered prescriber, and a facility providing methadone was defined as having a licensed OTP.[39] Using Google Maps Geocoding API (application programming interface) and the Python library GeoPandas,[40] physical addresses of the facilities were converted to latitude and longitude coordinates and matched with county maps to obtain corresponding county information. Duplicate practitioners providing buprenorphine at the same facility were removed. Buprenorphine prescribers at OTPs were included in the capacity to provide buprenorphine. Buprenorphine providers and OTPs sharing the same address were omitted in a robustness test separate from the main analysis. Facilities per 100 000 population were calculated at the county level for the capacity to provide buprenorphine or methadone.

Other covariates

Urbanicity, which served as a control and moderating variable in the study, was measured using the National Center for Health Statistics (NCHS) urban-rural classification scheme.[41] Counties were categorized as metropolitan, micropolitan, or rural (noncore). Because financial resources may enable treatment capacity, the study controlled for total county health and human services expenditures in 2017 in millions of US dollars[42] using an inverse hyperbolic sine (IHS) transformation for normality. The study also controlled for NCHS average drug poisoning deaths per 100 000 population over the period 2012 to 2016 (publicly available version)[43] since counties with higher overdose death rates should have greater need to expand OUD treatment capacity. Median age in the county, obtained from the 2019 American Community Survey, was also controlled for since adults aged 35 to 44 had the highest drug overdose death rate in 2020[1] and counties with more younger adult residents may need more treatment capacity. State indicator variables were included to account for differences between states that may affect factors related to the supply and demand for opioid treatment and interorganizational collaboration in their counties. For example, Medicaid was expanded in all states in this study except North Carolina, and while all states have prescription drug monitoring programs, only Ohio requires prescribers to check the prescription monitoring system. Thus, the inclusion of state indicators controls for state-level confounding factors, such as variation in Medicaid expansion, substance use laws, funding allocations, and attitudes toward substance use that could influence both opioid treatment availability and local collaboration in opioid response.

Statistical analysis

Associations between the interorganizational collaboration activity index (and its constituent items) and treatment capacity for buprenorphine and methadone provision were examined with regression models using ordinary least squares (OLS) estimation. Since the distributions for the dependent variables were positive and right-skewed, negative binomial regression models (NBRMs) were also estimated after transforming the continuous data to discrete counts of facilities per 100 000 population. Spatial autoregressive (SAR) models were also estimated due to the clustering of buprenorphine facilities per 100 000 population in contiguous counties, as determined by the Moran test for spatial dependence. The Moran test was insignificant for methadone facilities, but spatial models were estimated nonetheless for comparison with OLS estimates. SAR models are recommended when neighboring units are more similar than what would be expected randomly and thus OLS would produce biased estimates.[44] Spatial lag models were estimated with maximum likelihood estimation using a contiguity weighted matrix, *W*, whereby contiguous counties had the same positive weight and other counties had a zero weight. Statistical analysis was performed using Stata version BE/17 (Stata Corp., College Station, TX).

Results

The *n* for this study is 171 counties, including 77 metropolitan and 94 non-metropolitan (50 micropolitan and 44 rural) counties. The survey used for the independent variable attained a response rate of 47.8% (171 out of 358 counties), with similar rates for metropolitan and non-metropolitan counties. The response rate was highest for Colorado counties (56.3%) and lowest for Ohio counties (39.8%). There were no statistically significant differences between respondents and nonrespondents across key community characteristics, including population, population density, median household income, median age, and candidate vote share in the 2016 presidential election, and response rates were not statistically different between metropolitan and non-metropolitan counties in any state. The majority of respondents were county health directors or managers (61%), followed by county managers or administrators (24%), county commissioners (13%), and others (2%).

Descriptive statistics for all variables are reported in Table 1. The range for the interorganizational collaboration activity index was 0 to 5, with a mean of 2.63 and a standard deviation (SD) of 1.43. While the index showed a statistically significant difference in means of 3.0 and 2.32 (mean difference [M_{diff}] = 0.68, *P* = .001) for metropolitan and non-metropolitan counties, respectively, this difference decreased and was no longer significant after controlling for total county health and human services expenditures (M_{diff} = 0.08, *P* = .753). A factor analysis of the tetrachoric correlation matrix suggested a unidimensional structure, with a single extracted factor (eigenvalue = 2.73) explaining 79.24% of the variance across the index's items. Of the items that comprised the index, 81.3% of respondent counties joined a collaborative partnership with other governmental and nongovernmental organizations (eg, regional forum, taskforce), 78.4% worked with other agencies or local governments in activities such as sharing data and

Table 1. Descriptive statistics.

VARIABLE	OBS	MEAN	SD	MIN	MAX
Buprenorphine facilities per 100 000 population	171	12.23	9.04	0	51.80
Methadone facilities per 100 000 population	171	0.65	1.28	0	9.45
Collaboration activity index	171	2.63	1.43	0	5
Metropolitan	171	0.45	0.50	0	1
Micropolitan	171	0.29	0.46	0	1
Rural	171	0.26	0.44	0	1
Total county health and human services expenditures[a]	171	57.98	147	0	1700
Average drug poisoning death rate from 2012 to 2016[b]	171	15.74	5.74	2	30
Median age	171	41.03	5.11	25.70	59
Colorado	171	0.21	0.41	0	1
North Carolina	171	0.29	0.46	0	1
Ohio	171	0.20	0.40	0	1
Pennsylvania	171	0.19	0.40	0	1
Washington	171	0.10	0.30	0	1

[a]For 2017, in millions of US dollars.
[b]NCHS publicly available data capped at 30+ per 100 000 population at time of data collection.

information on opioid misuse/abuse, treatment, etc., 43.4% entered into an informal agreement with one or more local governments on opioid-related issues, 36.3% made organizational reforms (eg, consolidating departments, creating new ad hoc committees) based on a collaborative partnership for addressing the opioid crisis, and 23.4% entered into a formal agreement with one or more local governments on opioid-related issues.

The mean buprenorphine facilities per 100 000 population was 12.23 (SD = 9.04, range = 0-51.8), and the mean methadone facilities per 100 000 population was 0.65 (SD = 1.28 range = 0-9.45). Means for buprenorphine and methadone capacity did not differ significantly between metropolitan and non-metropolitan samples. For comparison, a national analysis of 3142 counties in 2016 reported a mean (SD) of 4.1 (5.8) buprenorphine facilities per 100 000 and a mean (SD) of 0.28 (0.96) methadone facilities per 100 000.[39] Thus, given some expansion since 2016, the capacity to provide OUD agonist treatment in the present study is likely higher than the average capacity to provide such treatment nationally, which may limit generalizability. Of the counties in the analytic sample, statistically significant variation across the 5 states for buprenorphine was observed, with North Carolina having the lowest capacity (10.35 facilities per 100 000 residents) and Washington having the highest (20.75 facilities per 100 000 residents) [$F(4, 166) = 5.33$, $P = .001$]. Variation across states was not significant for methadone capacity [$F(4, 166) = 0.57$, $P = .684$].

The OLS model results are displayed in Table 2. The interorganizational collaboration activity index did not vary with the capacity to provide buprenorphine only, but the index was positively associated with the capacity to provide methadone. Model 3 shows that, controlling for other covariates, a 1-point increase in the collaboration activity index was associated with 0.155 (95% confidence interval (CI) = 0.005, 0.304) more methadone, that is, OTP, facilities per 100 000 population. However, this association was not statistically significant when using robust standard errors (model 3). The coefficient for the interaction term between the collaboration activity index and a county being located in a rural area ($B = 0.338$, 95% CI = −0.014, 0.691) indicated a stronger association in rural counties than in metropolitan counties (model 4). The average marginal effect of collaboration activity engagement was 0.354 (95% CI = 0.110, 0.599) more facilities per 100 000 providing methadone in a rural area, compared to 0.075 (95% CI = −0.160, 0.309) and 0.016 (95% CI = −0.251, 0.284) in micropolitan and metropolitan areas, respectively. The marginal effects are plotted in Figure 1. Marginal effects with the 95% CIs for each urbanicity group separately are displayed in Figure A in the Supplemental material. The NBRM results using discrete counts of facilities per 100 000 population, which are presented in Table A in the Supplemental material, were largely consistent with the OLS results in terms of coefficient direction and statistical significance.

The results of the SAR model are displayed in Table 3. The spatial autoregressive coefficient (ρ) was statistically significant in the buprenorphine model, indicating spatial autocorrelation was biasing the OLS estimation results. Model 5 shows that, even after incorporating a spatial lag of the

Table 2. OLS results for OUD treatment capacity (n = 171).

VARIABLE	BUPRENORPHINE FACILITIES PER 100 000 POPULATION						
		MODEL 1			MODEL 2		
	UNADJUSTED *B* (SE)	ADJUSTED *B*	SE	RSE	ADJUSTED *B*	SE	RSE
Collaboration activity index	0.160 (0.487)	−0.241	0.499	0.468	0.274	0.904	0.681
Metropolitan	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Micropolitan	−0.581 (1.646)	1.905	1.662	1.361	4.412	3.555	2.802
Rural	1.474 (1.713)	3.807	2.063*	2.464	4.987	3.477	3.005*
Collaboration × metropolitan	–	–	–	–	Ref	Ref	Ref
Collaboration × micropolitan	–	–	–	–	−0.942	1.177	0.863
Collaboration × rural	–	–	–	–	−0.458	1.193	1.323
Expenditures (IHS transformed)	0.258 (0.452)	1.148	0.611*	0.555**	1.058	0.626*	0.587*
Avg. drug poisoning deaths	0.453 (0.116)***	0.450	0.121***	0.126***	0.443	0.123***	0.128***
Median age	−0.107 (0.136)	−0.238	0.147	0.197	−0.231	0.149	0.201
Adj. R^2	–	0.176	–	–	0.169	–	–
Akaike information criterion	–	1215.822	–	–	1219.126	–	–
VARIABLE	METHADONE FACILITIES PER 100 000 POPULATION						
		MODEL 3			MODEL 4		
	UNADJUSTED *B* (SE)	ADJUSTED *B*	SE	RSE	ADJUSTED *B*	SE	RSE
Collaboration activity index	0.168 (0.068)**	0.155	0.076**	0.111	0.016	0.071	0.086
Metropolitan	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Micropolitan	−0.059 (0.234)	0.203	0.252	0.175	0.028	0.135	0.335
Rural	−0.001 (0.243)	0.400	0.312	0.370	−0.371	0.532	0.514
Collaboration × metropolitan	–	–	–	–	Ref	Ref	Ref
Collaboration × micropolitan	–	–	–	–	0.059	0.521	0.134
Collaboration × rural	–	–	–	–	0.339	0.176*	0.258
Expenditures (IHS transformed)	0.107 (0.064)*	0.026	0.093	0.064	0.045	0.179	0.062
Avg. drug poisoning deaths	0.040 (0.017)**	0.052	0.018**	0.020***	0.056	0.094***	0.022**
Median age	−0.029 (0.019)	−0.047	0.022**	0.028	−0.053	0.018**	0.029*
Adj. R^2	–	0.057	–	–	0.071	–	–
Akaike information criterion	–	570.227	–	–	569.665	–	–

Abbreviations: IHS, inverse hyperbolic sine; REF, reference; RSE, robust standard error; SE, standard error.
Models 1 to 4 include state indicators.
***$P < .01$, **$P < .05$, *$P < .10$.

dependent variable in the model, the collaboration activity index still did not vary with the capacity to provide buprenorphine. Although spatial autocorrelation was not problematic for the methadone treatment capacity model, spatial lag models for such capacity were estimated and yielded similar results to the OLS estimation but with statistically significant estimates using robust standard errors for the collaboration activity index (model 7) and its interaction with rural areas (model 8). Spatial error models were also estimated for both the buprenorphine and methadone models, yielding results similar to those of the spatial lag models.

The estimated associations between the individual collaboration activities and methadone treatment capacity are displayed in Table 4. OLS and SAR models were estimated for

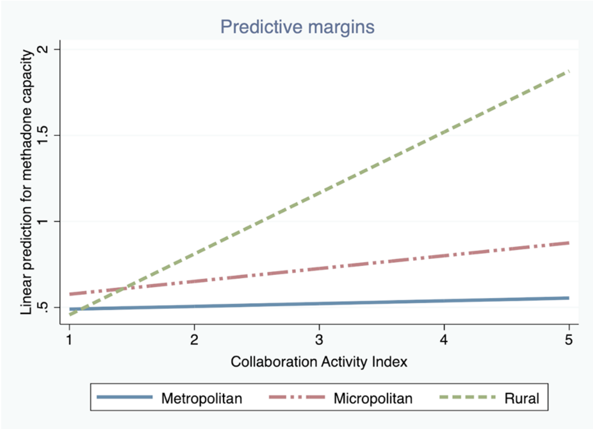

Figure 1. Predicted margins for the effect of interorganizational collaboration activity on methadone capacity (ie, OTPs per 100 000 population) by urbanicity.

each collaboration action and its interaction with urbanicity indicators separately, adjusting for all control variables. Two of the 5 activities, "worked with other agencies or local governments in activities such as sharing data and information on opioid misuse/abuse, treatment, etc." and "entered into a informal agreement with one or more local governments on opioid-related issues," showed positive and statistically significant direct effects on methadone treatment capacity in the OLS and SAR models. Interaction models suggested these effects and that of a third action, "made organizational reforms (eg, consolidating departments, creating new ad hoc committees) based on a collaborative partnership for addressing the opioid crisis," were stronger and statistically significant in rural counties than in their metropolitan or micropolitan counterparts. Thus, intergovernmental data and information sharing, formalizing interlocal agreements, and making organizational reforms based on collaboration were driving the results from the index measure. None of the individual collaboration actions showed a statistically significant association with buprenorphine treatment capacity.

Robustness checks

For robustness checks, OLS and SAR models were estimated for a combined buprenorphine and methadone treatment capacity dependent variable, yielding null findings for collaboration activity and its interaction with urbanicity indicators. The results for the methadone capacity model were also robust to including a binary indicator for the 3 counties in the dataset that shared the same regional LHD. Additionally, OTP facilities with a waivered provider of buprenorphine were removed from the capacity to provide methadone, and these waivered providers were also removed from the capacity to provide buprenorphine to achieve no overlapping waivered providers at OTP facilities. Results of the OLS and SAR models estimated for buprenorphine and methadone capacity separately are displayed in Supplemental Tables B and C, respectively, in the supplement. The results were consistent with collaboration activity not being associated with the capacity of buprenorphine at non-OTP facilities but being positively associated with the capacity to provide only methadone at OTPs and said association being the strongest in rural communities.

Finally, placebo tests were performed to test whether the collaboration activity index was correlated with methadone (OTP) facilities licensed long before the survey was disseminated. Collaboration activity reported at the time of the survey (2018-2019) should not be associated with OTP facilities established at least several years prior if such activity explained recent expansion of such facilities. Using their first full certification date,[38] OTPs licensed in 2010 or earlier, and in 2015 or earlier, were aggregated at the county level and facilities per 100 000 population were calculated for each time period. OLS estimates of the unadjusted and adjusted coefficients for the collaboration activity index are displayed in Table 5. Consistent with the above expectation, the index showed no association with facilities licensed in 2010 or earlier, or with facilities licensed in 2015 or earlier. However, 2 caveats should be noted. First, there was no way of knowing with this analysis which facilities opened and closed operations prior to 2010. Second, the cross-sectional data could not address the possibility for reverse causality between collaboration activity and methadone capacity expansion.

Discussion

Expanding access to MOUD is essential for saving and improving lives affected by OUD.[6,11] Collaboration and partnerships are a key element of a comprehensive opioid response[45] and could help promote evidence-based practices like MOUD. No government is likely capable of addressing opioid addiction and overdose alone and thus must work across organizational and jurisdictional boundaries so that integrated solutions match the scale and complexity of this epidemic.[20,21] This study examined treatment capacity for OUD with buprenorphine and methadone (ie, OTP) facilities per 100 000 population and found local governments' interorganizational collaboration activity did not vary with buprenorphine capacity but was positively associated with methadone capacity, and this association was stronger for rural communities than for their non-rural counterparts. Three specific collaboration actions—interorganizational activities such as data and information sharing, formal interlocal agreements, and organizational reforms based on collaboration—were found to drive the results from the index measure. Thus, both coordination (eg, data and information sharing and organizational reforms) and cooperation (eg, interlocal agreements, although interestingly only of the formal sort) facets of interorganizational collaboration appear important for local communities, mainly in rural areas, in having more methadone treatment capacity. Moreover, formal interlocal agreements and organizational reforms were

Table 3. SAR results for OUD treatment capacity (n = 171).

VARIABLE	BUPRENORPHINE FACILITIES PER 100 000 POPULATION					
	MODEL 5			MODEL 6		
	ADJUSTED *B*	SE	RSE	ADJUSTED *B*	SE	RSE
Collaboration activity index	−0.290	0.473	0.473	0.097	0.854	0.852
Metropolitan	Ref	Ref	Ref	Ref	Ref	Ref
Micropolitan	1.484	1.581	1.579	3.173	3.384	3.366
Rural	3.773	1.952*	1.952*	4.842	3.274	3.273
Collaboration × metropolitan	–	–	–	Ref	Ref	Ref
Collaboration × micropolitan	–	–	–	−0.628	1.116	1.111
Collaboration × rural	–	–	–	−0.430	1.123	1.123
Expenditures (IHS transformed)	1.172	0.578**	0.579**	1.106	0.590*	0.590*
Avg. drug poisoning deaths	0.404	0.116***	0.115***	0.399	0.117***	0.116***
Median age	−0.244	0.139*	0.139*	−0.237	0.140*	0.140*
ρ	0.267	0.105***	0.107**	0.260	0.106**	0.107**
Akaike information criterion	1213.675			1217.349		
Log likelihood	−593.837			−593.674		
VARIABLE	METHADONE FACILITIES PER 100,000 POPULATION					
	MODEL 7			MODEL 8		
	ADJUSTED *B*	SE	RSE	ADJUSTED *B*	SE	RSE
Collaboration activity index	0.156	0.073**	0.073**	0.021	0.130	0.130
Metropolitan	Ref	Ref	Ref	Ref	Ref	Ref
Micropolitan	0.203	0.243	0.243	0.061	0.512	0.511
Rural	0.409	0.302	0.302	−0.363	0.499	0.499
Collaboration × metropolitan	–	–	–	Ref	Ref	Ref
Collaboration × micropolitan	–	–	–	0.046	0.170	0.169
Collaboration × rural	–	–	–	0.341	0.171**	0.171**
Expenditures (IHS transformed)	0.027	0.089	0.089	0.045	0.090	0.090
Avg. drug poisoning deaths	0.053	0.018***	0.018***	0.058	0.018***	0.018***
Median age	−0.046	0.022**	0.021**	−0.052	0.021**	0.021**
ρ	−0.101	0.164	0.150	−0.128	0.165	0.150
Akaike information criterion	573.848			573.064		
Log likelihood	−273.924			−271.532		

Abbreviations: IHS, inverse hyperbolic sine; REF, reference; RSE, robust standard error; SE, standard error.
Models 5 to 8 include state indicators and a spatial lag parameter, ρ, for the dependent variable.
***$P < .01$, **$P < .05$, *$P < .10$.

the least and second-least frequently adopted actions, respectively, which could indicate activity involving more substantive collaboration. To date, no studies of which the authors are aware have examined this relationship. Accordingly, this study adds to the broader understanding of strategies used in community opioid response,[17-21] particularly in rural areas.[31-33]

That local government engagement in collaboration related to greater capacity to provide methadone but not buprenorphine

Table 4. Results for methadone treatment capacity with individual collaboration activities (n = 171).

MODEL[a]	VARIABLE	OLS: METHADONE FACILITIES PER 100000 POPULATION		
		NON-INTERACTION MODELS		
		ADJUSTED *B*	SE	RSE
9	Interorganizational data and information sharing[b]	0.591	0.250**	0.279**
10	(Non) Governmental collaborative partnership[c]	0.022	0.259	0.302
11	Informal agreement w/ another local government[d]	0.106	0.207	0.223
12	Formal agreement w/ another local government[e]	0.519	0.242**	0.345
13	Organizational reforms based on collaboration[f]	0.278	0.217	0.254
		INTERACTION MODELS		
		ADJUSTED *B*	SE	RSE
14	Interorganizational data and information sharing × rural	1.156	0.616*	0.667*
15	(Non) Governmental collaborative partnership × rural	0.050	0.627	0.677
16	Informal agreement w/ another local government × rural	0.136	0.502	0.680
17	Formal agreement w/ another local government × rural	1.431	0.550**	0.949
18	Organizational reforms based on collaboration × rural	1.525	0.562***	1.046
MODEL[g]	VARIABLE	SAR: METHADONE FACILITIES PER 100000 POPULATION		
		NON-INTERACTION MODELS		
		ADJUSTED *B*	SE	RSE
19	Interorganizational data and information sharing	0.597	0.242**	0.242**
20	(Non) Governmental collaborative partnership	0.027	0.251	0.251
21	Informal agreement w/ another local government	0.109	0.200	0.200
22	Formal agreement w/ another local government	0.518	0.234**	0.234**
23	Organizational reforms based on collaboration	0.276	0.210	0.210
		INTERACTION MODELS		
		ADJUSTED *B*	SE	RSE
24	Interorganizational data and information sharing × rural	1.158	0.591**	0.591**
25	(Non) Governmental collaborative partnership × rural	0.085	0.605	0.602
26	Informal agreement w/ another local government × rural	0.140	0.482	0.482
27	Formal agreement w/ another local government × rural	1.417	0.529***	0.529***
28	Organizational reforms based on collaboration × rural	1.528	0.539***	0.540***

Abbreviations: RSE, robust standard error; SE, standard error.
[a]All models (9-28) include urbanicity indicators, total county health and human services expenditures (IHS transformed), average drug poisoning death rate from 2012 to 2016, median age, and state indicators; interaction models (14-18, 24-28) include all constitutive and interaction terms (reference = independent variable × metropolitan).
[b]Worked with other agencies or local governments in activities such as sharing data and information on opioid misuse/abuse, treatment, etc.
[c]Joined a collaborative partnership with other governmental and nongovernmental organizations (eg, regional forum, taskforce).
[d]Entered into an informal agreement with one or more local governments on opioid-related issues.
[e]Entered into a formal agreement with one or more local governments on opioid-related issues.
[f]Made organizational reforms (eg, consolidating departments, creating new ad hoc committees) based on a collaborative partnership for addressing the opioid crisis.
[g]SAR models (19-28) include a spatial lag parameter, ρ, for the dependent variable.
$^{***}P < .01$, $^{**}P < .05$, $^{*}P < .10$.

in non-OTP settings was surprising. But there may be plausible explanations. Local government collaborations that forge formal interlocal agreements, enhance information and data sharing, and catalyze organizational reforms could facilitate the establishment of OTPs with an orientation toward public values, especially as buprenorphine treatment rates in public settings

Table 5. Placebo tests for methadone capacity OLS model (n = 171).

COLLABORATION ACTIVITY INDEX	METHADONE FACILITIES PER 100 000 POPULATION			
	2010 OR EARLIER[a]	*P*-VALUE	2015 OR EARLIER[b]	*P*-VALUE
Unadjusted *B* (SE)	0.016 (0.017)	.361	0.033 (0.020)	.104
Adjusted *B* (SE)[c]	0.002 (0.018)	.930	0.024 (0.021)	.245

Abbreviation: SE, standard error.
[a]Methadone facility was fully certified in the year 2010 or earlier.
[b]Methadone facility was fully certified in the year 2015 or earlier.
[c]Adjusted for urbanicity, total health and human services expenditures, average drug poisoning death rate from 2012 to 2016, median age, and state indicators.

have historically lagged behind those in private practice settings.[46] Public administration research has long studied "publicness" or "a characteristic of an organization which reflects the extent the organization is influenced by political authority" that will, in turn, partly determine the extent to which public values are realized.[47] While descriptive measures of publicness (eg, ownership, percentage of government funding) have provided mixed evidence[48] and explained little variation in patient outcomes for substance use treatment,[49] a recent study of acute care hospitals found that publicness dimensions were positively associated with collaboration for generating community benefits.[50] OTPs have publicness traits whether or not they embody greater publicness than offices of waivered providers only. Bachhuber et al[51] found that 8.5% and 33.5% of OTPs were operated by a government or a nonprofit, respectively, and these OTPs were more likely than their for-profit counterparts to offer comprehensive services. Also, an analysis by the authors of 2019 National Survey of Substance Abuse Treatment Services (N-SSATS) data[52] displayed in Supplemental Table D (available online) found that 73.7% of non profit OTPs—which are defined in the N-SSATS as having "private non-profit" ownership—received federal, state, county, or local funding, compared to 30.3% of for-profit OTPs as defined in N-SSATS. Nonetheless, concerns over buprenorphine accessibility, namely uneven geographical distribution of waivered providers, unused patient capacity, and provider uncertainty about insurance reimbursement,[53] remain unaddressed and OTP expansion may help alleviate these concerns as they relate to overall agonist MOUD availability.

The use of and eligibility requirements for Substance Abuse Prevention and Treatment Block Grant (SAPTBG) funding may also explain why public and nonprofit OTPs could be more responsive to local government collaboration for opioid response. For-profit OTPs have not been eligible to apply for SAPTBG funds through their state government until 2021.[54] SAPTBG funds are distributed to states and intended as a safety net for uninsured patients in need of substance use treatment mainly through outpatient facilities. Even with Medicaid expansion extending coverage to unemployed and low-income people who receive substance use treatment, SAPTBG funds are still needed for reimbursing treatment providers for more comprehensive treatment or for services not covered by Medicaid, as well as for paying for those who opt not to enroll in Medicaid.[55] State grantees must have the ability to make subawards to local government entities and community-based (ie, nongovernmental) organizations that provide substance use prevention, treatment, and recovery services,[56] which could promote both local collaboration on opioid response and OTP expansion.

SAMHSA's State Opioid Response Grant (SORG) might also partly explain why local collaboration was positively associated with capacity to provide methadone (and buprenorphine at OTPs). In 2018, several states, including 2 in this study (Colorado and Washington), used SORG funding to improve access to methadone and other MOUD for the uninsured through providing financial assistance.[57] A number of states and territories reported back to Congress that they had strengthened coordination efforts with local health agencies, community health clinics, and other organizations for MOUD expansion using SORG funds.[58]

Perhaps a less-surprising finding from this study is that the association between collaboration activity and the capacity to provide methadone was stronger in rural than in non-rural counties. While collaboration has been identified as an important strategy in rural opioid response,[31-33] limited evidence of its impact exists. Rural communities are smaller in terms of population and have shown lower rates of implementing some opioid response and prevention activities than their urban counterparts,[18] although this distinction did not appear in counties with high overdose mortality rates.[17] Thus, the marginal benefits to collaborating on opioid response could be higher for the average rural county than its urban counterpart. One alternative explanation for this finding may have to do with all states in this study except North Carolina opting for Medicaid expansion under the Patient Protection and Affordable Care Act of 2010. Medicaid expansion increased the number of OTPs accepting Medicaid and methadone dispensing increased in expansion states that cover methadone in their Medicaid program.[59] Additionally, the expansion of Medicaid led to larger gains in insurance coverage for rural areas,[60] which could partly explain the increase in methadone capacity and the need for local governments to collaborate on opioid response. Another explanation may have to do with methadone maintenance therapy (MMT) requiring patients to receive daily dosages while physically present at an OTP. Because accessing OTPs in and from rural areas is more difficult and time consuming,[61,62] collaboration between rural OTPs and local government and health officials may be needed to provide support for transportation services to MMT, especially as access to buprenorphine and naltrexone and the use of telehealth for OUD in the home continues to develop in rural areas.[63,64]

This study does not imply that local collaboration resulting in OTP and MOUD expansion is likely or without problems in rural communities. Interagency and regional collaboration to address the opioid epidemic has proven challenging in rural communities with little resources.[31] Collaborative efforts can take time and energy away from other priorities and fail to achieve intended outcomes. Indeed, this study found a negative, albeit statistically insignificant, adjusted coefficient for collaboration on buprenorphine capacity and stronger, yet still statistically insignificant, negative associations in non-metropolitan areas. Expanding OTPs into rural areas is also met with challenges, namely the large geographical areas found in rural communities and the lack of available behavioral health resources.[65] Hub and spoke models are an example of a systems-level intervention being adopted to expand access to MOUD, but they often require well-established OTPs to serve as the hub and provide foundational support to the spokes, which are typically office-based providers.[65] This model presumes that hubs will have the capacity to lead, provide technical assistance, and build and sustain interorganizational partnerships across treatment, behavioral health, and harm reduction providers. A lack of interest on the part of the spokes has been demonstrated due to stigma, staff capacity concerns, and an inability of hubs to demonstrate the financial benefits of participation and achieve financial solvency through an MOUD business model.[66]

In addition to reducing barriers to establishing new OTPs, state and local governments could work to improve MOUD access for Medicaid and Medicare recipients, reduce burdens for initiating MMT, expand at-home treatments, and improve OTP integration within health care delivery systems.[67] The burden is high for patients seeking MMT for MOUD due to the arduous and archaic rules that have been in place for more than 50 years. Requiring patients to report to OTPs to receive a daily dose appears to serve the interests of the OTPs rather than the patients. Changes observed during the COVID-19 pandemic, such as use of take-home doses and increased telehealth, indicate there is room to adjust these requirements so they no longer create barriers to care.[68]

Limitations

This study is limited by the 5-state sample. As noted, the study may lack generalizability given that the capacities to provide buprenorphine and methadone were likely higher in the analytic sample than nationally. This study also focused only on capacity to provide agonist therapies for OUD and did not consider the capacity to provide extended-release naltrexone, an antagonist MOUD which, once detoxification was achieved prior to initiation, was similarly effective to buprenorphine in reducing opioid relapse.[69] Also, interorganizational collaboration was measured in 2019 and MOUD facilities were measured approximately 2 years later, reducing the likelihood of bias from reverse causality (ie, expanding capacity to provide methadone may induce more local collaboration, and vice versa), but county-level decisions about the level of interorganizational collaboration are endogenous, despite controlling for a number of covariates in the models. Finally, collaboration was limited in its measurement through 5 survey items and viewed only from the perspective of local government officials who may not be aware of the extent to which other community stakeholders, such as public libraries,[70] pharmacies,[32] or university faculty and local residents,[33] were involved in collaborative opioid response. The items were also not designed to capture the strength of or commitment to interorganizational collaboration, such as the level of resources committed to a collaboration, which further limited the study.

Future research

Future research complementing the grass-tops perspective taken in this study with a grass-roots perspective of collaborative opioid response[33] would provide a more complete picture of how rural collaboratives can better address OUD, disparities in MOUD access, and associated adverse health outcomes. Future work informing how local communities can better manage or overcome challenges associated with conflicting agendas of parties to collaborative opioid response, such as those of public health and police departments,[29] is also needed. Examining how more specific coordination alternatives, such as surveillance systems used by LHDs and EDs,[25] and cooperative arrangements, such as LHD-hospital collaboration in health planning,[26] relate to, or result in, other key outputs or outcomes of local opioid response efforts beyond treatment availability would also be informative.

Conclusion

Expanding access to MOUD is a key pillar of a multipronged, evidence-based strategy to address OUD and related overdose. Reducing opioid-involved overdose is a tall task for any government or organization, especially in rural communities, to tackle alone. Local governments and their health departments can collaborate across organizational lines to build capacity and achieve a more adequate and comprehensive opioid response. Their collaboration activity was associated with more capacity to provide methadone (and buprenorphine provided at OTPs), and this association was stronger for rural than for urban or suburban communities. Of the collaboration actions analyzed, interorganizational activities such as data and information sharing, formal agreements between local government jurisdictions, and organizational reforms based on collaboration were key. The findings highlight the importance of local government collaboration in rural opioid response and offer preliminary evidence to policymakers for supporting the development of rural collaboratives to address the opioid epidemic.

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Author Contributions

WS and MD led the study conception and design. The survey was developed and managed by WS and TS. All other data collection was carried out by WS and MD. The data analysis was conducted by WS and MD. The first draft of the manuscript was written by WS, and MD and TS provided critical edits and review. All authors read and approved the final manuscript.

Supplemental Material

Supplemental material for this article is available online.

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