



RESEARCH ARTICLE

# A Geographic Perspective on Opioid Misuse: Substance Abuse Treatment Deserts in Southwestern Ohio

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## ABSTRACT

**Background:** The opioid crisis is one of the most pressing public health issues facing Ohio, with an impact unevenly distributed across the state. This work examined geographical barriers to substance abuse treatment in southwestern Ohio through examining geographical areas with limited access to substance abuse treatment services and identifying substance abuse treatment deserts.

**Methods:** The study domain included the 13 counties in the Ohio Mental Health and Addiction Service's Cincinnati region. Publicly available substance use disorders treatment data were collected from government agency resources, pharmaceutical websites, and web searches. Substance abuse treatment deserts were defined as areas in the 13-county study area that were not within a 15-minute drive from a treatment center.

**Results:** We found large portions of the study region that were considered a substance abuse treatment desert for methadone and naltrexone/buprenorphine clinics, behavioral health treatment centers, and both medicated assisted treatment (MAT) and behavioral health treatment combined. Out of the 2 017 337 total persons living in the 13-county study area, 17% (n = 342 872) live in a desert for all MAT and behavioral treatment. Similarly, 19.7% (n = 396 581) live in a desert for naltrexone/buprenorphine treatment, 60.9% (n = 1 227 560) live in a desert for methadone treatment, and 19.7% (n = 396 581) live in a desert for behavioral health treatment.

**Conclusion:** We successfully defined substance abuse treatment deserts in southwestern Ohio, which will be useful for future research to determine its association with opioid-related health outcomes. This resource is publicly available online (<https://doi.org/10.5281/zenodo.4011051>).

**Keywords:** Opioid abuse; Treatment desert; Medicated assisted treatment; Behavioral health treatment; Geospatial

## INTRODUCTION

In recent decades, an opioid epidemic has gripped the United States resulting in an unprecedented public health crisis.<sup>1</sup> Between 1999 and 2019, the number of opioid-involved overdose deaths increased almost 6-fold, with opioids involved in nearly 70% of

the over 67 000 overdose deaths in 2019.<sup>2,3</sup> That same year, an estimated 2 million people were diagnosed with an opioid use disorder; of those, only about 20% received substance use treatment in the previous year.<sup>3</sup> The necessity of access and availability to specialty drug treatments for opioid dependence is highlighted by studies that have demonstrated that these types of treatments





reduce the risk of overdose mortality.<sup>4</sup> While affordability of treatment increased in recent years for many low-income individuals due to Medicaid expansion under the Patient Protection and Affordable Care Act of 2010,<sup>5</sup> geographic accessibility continues to be an area of concern. Cummings and colleagues<sup>6</sup> found that while approximately 60% of counties in the United States have at least 1 outpatient substance abuse treatment facility that accepts Medicaid, this rate was lower in many southern and midwestern states. Furthermore, counties with a higher percentage of Black, rural, and/or uninsured residents were less likely to have a facility that accepted Medicaid. Other studies suggest that primary care providers who practice in rural areas and/or communities with larger Black and Latinx populations have fewer, geographically, behavioral health professionals providing mental health and substance use services.<sup>7</sup>

Ohio has been hit especially hard by the epidemic, with opioid overdoses resulting in over 500 000 total years of lost life from 2010 to 2016.<sup>8</sup> In 2007, unintentional drug poisoning became the leading cause of injury death in Ohio and, unfortunately, this remains true as of this writing. As an epicenter of the crisis, the opioid mortality rate doubled every 3 years from 1999 to 2016.<sup>9</sup> As in much of the country, there has been an uneven distribution of opioid overdose mortality throughout Ohio. A geospatial analysis using data from 2010 through 2017 found that the increasing rates of the opioid overdose epidemic in Ohio were driven by 12 epidemic hotspot areas, 5 of which are part of the Greater Cincinnati area.<sup>10</sup> Of these, 3 were in the Appalachian Region, a cultural, social, and economic region that spans the Appalachian Mountains.<sup>11</sup> Rural Appalachian counties have the highest mortality rates in the region with 65% higher overdose mortality compared to non-Appalachian counties.<sup>12</sup>

The concept of deserts to describe geographical areas with limited access to goods and services has been used in popular discourse in recent decades. The term food desert was initially used to describe geographic areas where people experienced physical and economic barriers to accessing healthy food.<sup>13</sup> Older studies utilized the former Food Desert Atlas from the United States Department of Agriculture Economic Research Service, which provided a food desert measure for each census tract. A census tract was classified as low access if at least 500 residents, or 33% of the tract population, lived over 10 miles from a supermarket, based on Euclidean distance.<sup>14</sup> In more recent literature, the term food desert is used to imply the inability to easily acquire food with high nutritional content, rather than a lack of access to food per se.<sup>15,16</sup> This has led researchers to consider other factors that could impact food desert status. Potential factors include explicit and implicit travel costs for consumers in addition to food costs<sup>15</sup> and perceptions of the acceptability of food stores and shopping locations.<sup>17</sup>

The term health care desert has also been applied to areas where residents of an area or region must travel significant distances to obtain health care services.<sup>18</sup> Specifically, areas where disparities

in access to pharmacy, hospital, trauma, and medical services exist have been identified as deserts.<sup>19-21</sup> Additionally, treatment deserts have been used to conceptualize restricted access to treatment in rural areas. A scoping review of opioid misuse in rural America found a theme of treatment deserts in 2 key areas: 1) areas where a small proportion of primary care physicians received buprenorphine waivers and 2) areas where treatment facility types were further for Appalachian versus non-Appalachian and rural versus micropolitan/metropolitan patients.<sup>21</sup>

These examinations of food and health care deserts have been modes through which to identify and explore barriers to goods and services, vital to the health and well-being of vulnerable individuals and communities. Applying a similar paradigm as the original use of the term food desert, this project examined geographical barriers to substance abuse treatment in a greater Cincinnati, Ohio, region, and explored the existence of substance abuse treatment deserts, as defined by individuals living more than a 15-minute drive from a treatment center.

## METHODS

### Setting and Design

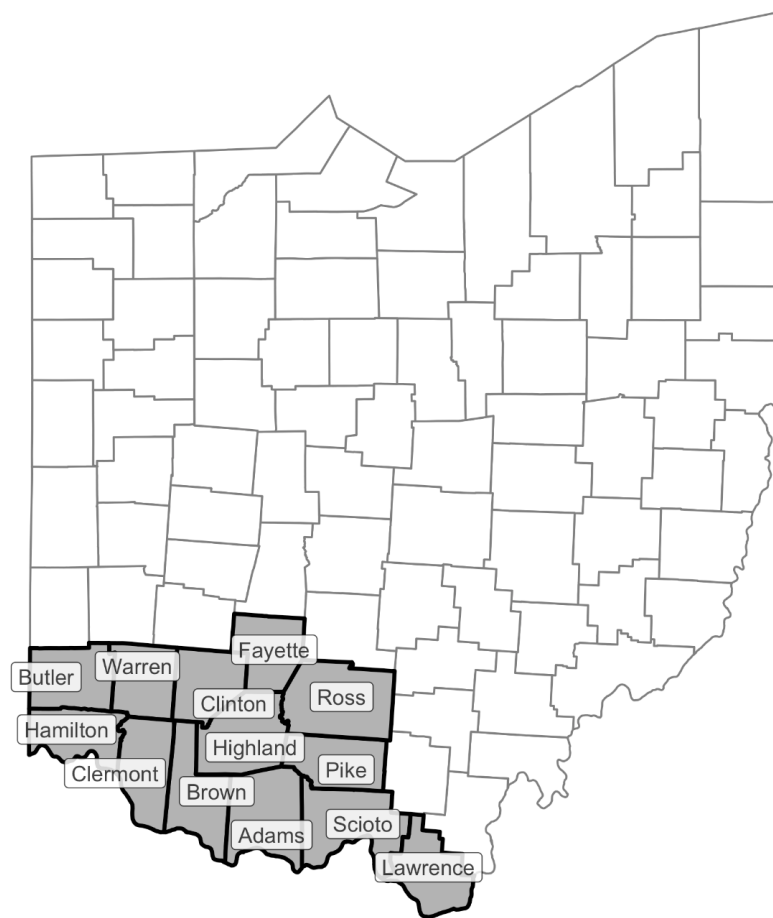
Included counties were part of the Ohio Department of Mental Health and Addiction Services (OMHAS) Cincinnati region: Adams, Butler, Brown, Clermont, Clinton, Fayette, Hamilton, Highland, Lawrence, Pike, Ross, Scioto, and Warren.<sup>22</sup> See Figure 1.

### Procedures

Publicly available substance abuse treatment data were obtained from the Substance Abuse Mental Health Services Administration (SAMHSA) website (<https://findtreatment.samhsa.gov/>), the OMHAS Emerald Jenny Treatment Finder tool (<https://www.emeraldjennyfoundation.org>), the Commission on Accreditation of Rehabilitation Facilities (CARF) website (<http://www.carf.org/providerSearch.aspx>), the Ohio Behavioral Health Directory (<https://prod.ada.ohio.gov/directory/>), and the Find a Treatment Provider tool on the Vivitrol website (<https://www.vivitrol.com/find-a-treatment-provider>) between August 2019 and February 2020. Additional facilities were found by using Google ([www.google.com](http://www.google.com)) to search substance+abuse+treatment and the respective county. Discrepancies between websites for contact information and services were reconciled by calling the facility to confirm the correct address and available services.

### Measures/Outcomes

The street addresses of treatment facilities were geocoded using a standalone, validated geocoder based on Census TIGER/Line street range address files.<sup>23,24</sup> A geocode is considered accurate if coordinates are placed on the correct street or within the correct street segment, and the input address text and resulting geocoded address text are at least a 50% match. The current study excluded treatment facilities that could not be accurately geocoded. Out of 260 treatment centers, 250 were able to be accurately geocoded.



**Figure 1. Map of the Study Regions, the OMHAS Cincinnati Region**

Polygons consisting of 15-minute drive times from each treatment center were generated using the openroute service API.<sup>25</sup> We defined 4 types of deserts based on the 3 treatment types and access to any of the treatment types (naltrexone/buprenorphine, methadone, behavioral, and overall). The union of these individual access polygons for each treatment facility was used to define areas of treatment access for each desert type. Substance abuse treatment deserts were defined as areas in the 13-county study area not covered by the treatment access areas. To estimate the number and percentage of people living in substance abuse treatment desert areas, population estimates for the 13-county study area were obtained from the 2010 US Census at the census block level. Each census block was classified as a substance abuse treatment desert if it overlapped with the defined desert area. Geospatial and statistical computing was done using R, version 3.6.3.<sup>26</sup> Specifically, we used the sf package for all geospatial calculations.<sup>27</sup>

## RESULTS

Figure 2 shows maps of the 13-county study area with substance abuse treatment desert regions highlighted in colors for each respective treatment type. The upper left map panel combines deserts for all substance abuse pharmacological and behavioral

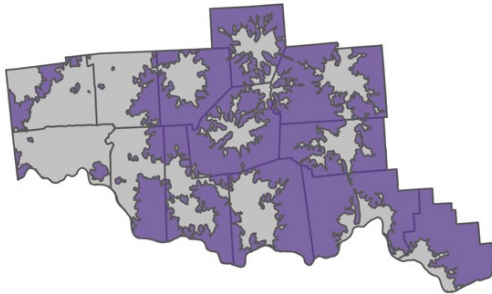
treatment deserts, meaning that these areas lack access to all 3 types of treatments.

Overall, out of the 2 017 337 total persons living in the 13-county study area, 17% ( $n = 342\,872$ ) live in a desert for all MAT and outpatient behavioral treatment. Similarly, 19.7% ( $n = 396\,581$ ) live in a desert for naltrexone/buprenorphine treatment, 60.9% ( $n = 1\,227\,560$ ) live in a desert for methadone treatment, and 19.7% ( $n = 396\,581$ ) live in a desert for behavioral treatment. When considering the fraction of population living in a substance abuse treatment desert by county, the percentages ranged from 5% to 57%. Table 1 presents the population and percentage of total population living in a substance abuse treatment desert for each county in the study region. The table presents the data substance abuse treatment desert percentage for all counties in the study region. For the 13-county study area region, the largest desert centered on methadone (61%), with many counties not having access to any methadone treatment. Naltrexone/buprenorphine followed (20%), and outpatient behavioral treatment was next (18%).

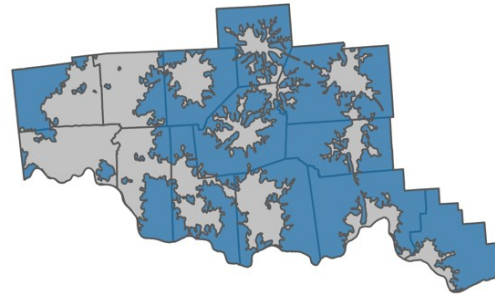
The counties fell into 2 subregions. The first is a 3-county subregion where the substance abuse treatment desert was 7% or less



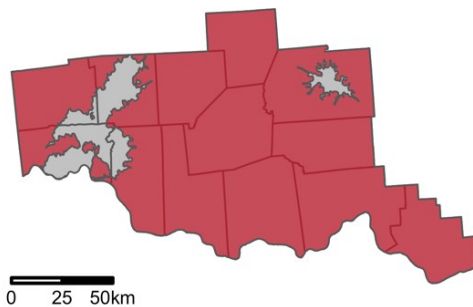
### All MAT and Behavioral



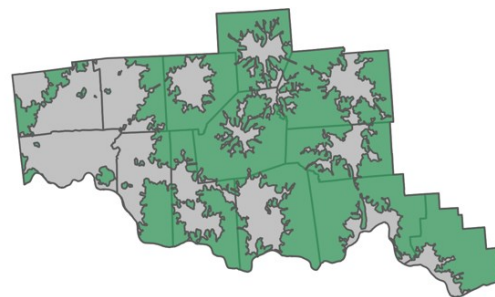
### Naltrexone/Buprenorphine



### Methadone



### Behavioral



0 25 50km

**Figure 2. Maps of the 13-County Study Region with Substance Abuse Treatment Deserts Highlighted in Color for Each Type of Treatment**

of the individual county's population, indicating a greater availability for substance use disorder treatment (5% to 7%). The second is a 10-county region where the substance abuse treatment desert was greater than 22% of the individual county's population (22% to 57%), indicating a dearth of treatment.

## DISCUSSION

In this project, we identified substance abuse treatment deserts in a 13-county region in southwestern Ohio. Substance abuse treatment deserts were defined as areas that were not within a 15-minute drive from a treatment center, including methadone and naltrexone/buprenorphine clinics, behavioral health treatment centers, and both medicated assisted treatment (MAT) and behavioral health treatment combined.

Further examination of subregional differences in the identified regions looked at differences in Appalachian status, overdose mortality rates, opioid dispensing rates, and poverty rates. Although no counties within the first subregion overlapped with the Appalachian region, 8 of the 10 counties in subregion 2 were part of the Appalachian region. This second subregion also contained the largest substance abuse treatment desert area. In the substance abuse treatment desert subregion where treatment was more available, the average opioid dispensing rate per 100 residents was lower (51.6% versus 70.9%), as was the poverty rate (11.7% versus

18.6%).<sup>28,29</sup> While differences in the poverty and opioid dispensing rates were found between the 2 regions, delineation between the 2 regions in terms of accidental drug overdose rates is unclear. This may be related to specific classes of opioid mortality on the county level. Monnat and colleagues found that while drug mortality rates overall were higher in counties with higher economic disadvantage and opioid dispensing rates, counties with higher heroin mortality and very high and rapidly growing mortality rates from all types of opioids were more urban and less economically disadvantaged.<sup>30</sup>

Butler and Hamilton counties were categorized into the first subregion. While residents had more access to treatment, the number and age-adjusted accidental drug overdose rates for 2013 through 2018 had ranges corresponding with regions that have a dearth of treatment.<sup>31</sup> Butler and Hamilton counties are more urban with the first and second highest proportion of urban population in the study region.<sup>32</sup> These counties also had the second and fourth lowest poverty rates of the study region.<sup>29</sup> Monnat and colleagues classified these counties as 2 with a very high and rapidly growing mortality rate from all types of opioids with data from 2014 to 2016.<sup>30</sup> This aligns with their conclusion that higher overdose rates cannot be fully explained by the rate of opioid prescriptions dispensed and availability of substance abuse treatment.<sup>30</sup>



The third county in the first subregion, Warren County, had the lowest overdose mortality rate of any of the counties in the study region, the lowest dispensing rate, and the lowest poverty rate.<sup>28,29,31</sup> The data from this county and the other subregion, aside from 1 outlier county, coincided with the main finding of Monnat and colleagues,<sup>30</sup> that overall mortality rates were lower in those counties with less economic disadvantage and lower opioid dispensing rates.

The outlier in the second subregion, Highland County, had the largest substance abuse treatment desert, the highest opioid dispensing rate, and a poverty rate comparable to the other counties, yet the number and age-adjusted accidental drug overdose rate for 2013 to 2018 was 23.6, the 48th highest rating in the state.<sup>31</sup> The other 9 counties in the second group (7 of which enclose Highland County) had ratings ranging from 2nd to 19th. Despite the lower accidental drug overdose rate, substance abuse is still a significant concern in Highland County. Not only was illegal drug use listed as the number one health issue by the general public and health professionals in 2016,<sup>33</sup> but the Centers for Disease Control and Prevention has identified Highland County as 1 of 220 counties in the United States particularly vulnerable for significant increases in HIV and hepatitis C infections due to injection drug use.<sup>34</sup> A further examination of this county is warranted to identify how other county-level protective factors could be mobilized by communities when medical and behavioral health substance

abuse interventions are more limited. A case study may find that factors such as social capital<sup>35</sup> or local initiatives, such as the implementation of the Byrne Criminal Justice Innovation program,<sup>36</sup> may be driving forces in preventing overdose deaths.

A strength of our analysis was that we utilized driving time, rather than “as the crow flies” distance to define proximity to treatment facilities. Currently, there is little evidence on the impact of total travel time for treatment adherence among substance use disorder patients. We chose 15 minutes as our threshold for the accessibility of treatment because regular access to treatment is more similar to regular access to health food retailers (which usually use 15 minutes) rather than to acute care (which usually use 60 minutes), which is required much less often and regularly. Regardless, the threshold of accessibility as a driving time likely differs among patients based on their personal behaviors and beliefs, as well as on how much they usually travel daily, their access to a vehicle, and whether or not they live in a rural or urban area.

A limitation of this project is that we only considered transportation by car, which misrepresents patients that may lack access to a car. Patients that walk or utilize public transportation systems, such as a bus, are not represented in our calculation of these treatment deserts. Future work should extend the definition of treatment deserts to include travel time related to other modes of transportation. Our existing treatment deserts could be combined

**Table 1. Population (and percent of total population) Living in Substance Abuse Treatment Deserts Overall and by County in the Study Region**

County	All	Naltrexone/Buprenorphine	Methadone	Outpatient behavioral
Entire study region	342 872 (17%)	396 581 (20%)	1 227 560 (61%)	360 275 (18%)
<b>Subregion 1</b>				
Butler	17 281 (5%)	53 145 (14%)	303 086 (82%)	17 281 (5%)
Hamilton	50 060 (6%)	58 814 (7%)	299 016 (37%)	50 060 (6%)
Warren	14 994 (7%)	15 019 (7%)	112 501 (53%)	28 076 (13%)
<b>Subregion 2</b>				
Clermont	43 018 (22%)	43 018 (22%)	111 454 (56%)	43 018 (22%)
Fayette	9 792 (34%)	10 895 (38%)	29 030 (100%)	10 120 (35%)
Ross	34 170 (44%)	36 158 (46%)	42 790 (55%)	34 170 (44%)
Scioto	36 426 (46%)	36 937 (46%)	79 499 (100%)	36 426 (46%)
Adams	14 008 (49%)	14 008 (49%)	28 550 (100%)	14 008 (49%)
Clinton	22 600 (54%)	22 600 (54%)	42 040 (100%)	22 611 (54%)
Brown	24 576 (55%)	24 576 (55%)	44 846 (100%)	24 576 (55%)
Lawrence	35 060 (56%)	38 708 (62%)	62 450 (100%)	35 060 (56%)
Pike	16 050 (56%)	17 866 (62%)	28 709 (100%)	16 050 (56%)
Highland	24 837 (57%)	24 837 (57%)	43 589 (100%)	28 819 (66%)

Percentages were calculated as the fraction of the total population.





with census survey data on the number of vehicles per household to estimate where this limitation would be the greatest.

## PUBLIC HEALTH IMPLICATIONS

The geographically-defined regions identified in this study could be useful to study their impact on substance use disorder diagnosis and treatment outcomes. The geographically-defined substance abuse treatment desert locations are available to the public online as GeoPackage data files (<https://doi.org/10.5281/zenodo.4011051>). Approximately 1 in 6 of the individuals residing within the study area lived more than a 15-minute drive from any type of MAT or behavioral treatment facility. Consistent with findings of other researchers,<sup>37</sup> we found treatment deserts disproportionately distributed across rural communities. Furthermore, if there are substance abuse treatment centers in rural areas, those living in rural communities face transportation barriers due to distance and limited public transportation options.<sup>38</sup> These transportation and distance barriers may contribute to inadequate substance abuse treatment or relapse. As has been proposed, offering MAT through primary care providers or expanding transportation services through substance abuse treatment programs are potential ways to improve access and utilization for those living in substance abuse treatment deserts.<sup>39,40</sup>

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