Substance Abuse Treatment, Prevention, and Policy

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COVID-19 public health restrictions and opioid overdoes: a summative content analysis of emergency medical services records in three Texas counties

S. Scott Graham[1,2*], Nandini Sharma[3], Tristin B. Hooker[2], Kimberlyn Harrison[2] and Kasey Claborn[1,4]

Abstract

Background With the broad recognition of increased U.S. opioid overdose (OOD) rates between 2020 and 2021, media, public health, and healthcare organizations have raised significant concerns over the emergence of a simultaneous COVID-19-opioid "twindemic." Research in this area has explored the possible relationships between negative externalities associated with the pandemic and/or COVID-19 public health interventions and increased risks for opioid use and overdose alongside diminished outcomes following OOD events.

Methods The study offers a summative content analysis of Emergency Medical Service (EMS) responses to opioid overdose (OOD) events before and after the institution of COVID-19 restrictions. Specifically, the study investigates three Texas counties to evaluate changing OOD rates, patient demographics, and OOD event features. The analysis uses a previously validated machine learning tool to identify OOD events and conducted a summative content analysis of identified events.

Results A total of 1170 OOD responses events were identified in the three-county dataset. This includes 874 in Travis County, 242 in El Paso County, and 54 in Williamson County. Each county experienced modest changes in EMS calls for OOD events between the pre-restriction and public health restriction time periods. Travis County's OOD event rate declined from 454 to 420. El Paso's increased from 103 to 139, and Williamson County's increased from 23 to 31. These changes were not significant as percentage of possible OOD events or based on by-month comparison. The notable differences between pre-restriction and public health restriction periods were significant decreases in documentation of patient race/ethnicity in Travis and Williamson Counties, significant decreases in housing insecurity and use alone in Travis County, and an increase in transport refusal after treatment in the field in Travis County.

Conclusions Ultimately the results presented here problematize prevailing analyses about the so-called opioid-COVID-19 "twindemic." The data further support emerging trends about substantial geographic variation and show some ways that COVID-19 mitigation measures may have improved conditions for some populations, particularly in

*Correspondence:
S. Scott Graham
ssg@utexas.edu

Full list of author information is available at the end of the article

terms of housing security. Additionally, the results presented here indicate that further attention should be paid to the effects of first responder stress on documentation quality.

Keywords Opioids, Overdose, COVID-19, Epidemic

Introduction

With the onset of the COVID-19 pandemic and early public health precautions, emergency department (ED) visits initially dropped up to 40% for all medical conditions and emergencies [1]. Yet, in the first year of the pandemic, while overall ED visits remained lower than in previous years, both the count and rate of overdose-related visits increased up to 10.5% according to one study of multiple US health systems [1]. This increase coincides with the CDC's reported 91,799 drug overdose deaths in the U.S. in 2020, increased 30% over 2019 [2, 3]. Overdose rates increased an additional 15% between 2020 and 2021 [4]. With the broad recognition of increased U.S. opioid overdose (OOD) rates between 2020 and 2021, media, public health, and healthcare organizations have raised significant concerns over the emergence of a COVID-19-OOD "twindemic." [5]. Attention to this twindemic tends to focus on questions about the possible relationships between negative externalities associated with the pandemic/pandemic public health interventions and increased risks for and/or diminished outcomes following OOD events. In particular, the available research has pointed to the potential for physical distancing to increase social isolation which is known to be associated with drug use and may also decrease the likelihood that an OOD will be noticed in time to intervene [3, 6, 7]. Additionally, some research has pointed to supply chain disruptions and the effects on naloxone distribution as a possible variable in OOD outcomes during the pandemic [6, 8, 9].

The primary goal of this paper is to evaluate the extent to which twindemic analyses and related hypotheses about social isolation, opioid use, and naloxone distribution apply to three Texas counties. Accordingly, we describe the results of a summative content analysis of emergency medical services (EMS) records from Travis, Williamson, and El Paso County. This paper offers distinctive contributions to the emerging literature in two primary ways. First, our analysis is comparative in nature. We assess the differences in outcomes between three counties selected for demographic, socio-economic, and COVID-impact variances. This approach is essential as it has become increasingly clear that there are significant regional and demographic variance in post-COVID OOD incidence rates and outcomes [10–13]. These findings parallel prior research on geographic, racial, ethnic, and socio-economic disparities reported both during the opioid epidemic and COVID-19 individually [14–16]. Secondly, this study focuses on EMS records of OOD events. While the majority of OOD surveillance studies focus on ED records, we believe analysis of EMS records is especially important for exploring the effects of COVID-19. As a result of the broad reduction in ED visits generally and a widespread reticence to pursue tertiary care during the height of the pandemic, EMS records offer an important and underutilized resource for understanding opioid use and OOD events. After a review of the relevant literature, we outline our methodological approach which combines techniques from machine learning and content analysis. Then, county-by-county, we describe the differential impacts of COVID-19 and associated public health measures on OOD events- frequency and nature. Both prior to and during the COVID-19 pandemic, EDs served as the primary healthcare point of contact for overdose patients and as the primary reporting site for data studying fatal and nonfatal overdoses. Yet, as we note, this reporting is complicated by a number of local and systemic factors, including the reliance on ED reporting, the variation of demographic and community-level factors, the need to disaggregate fatal and nonfatal overdoses, and the variation in local public health systems and legal practices governing EMS transport.

Literature review

In recent years, there have been significant research efforts devoted to understanding the relationship between COVID-19, associated public health interventions, and the opioid epidemic. A particular focus in this context has been an effort to explore how pandemic disruptions to the healthcare system, supply-chain logistics, and personal lives may have accelerated OOD rates and diminished OOD outcomes. Available evidence suggests that both strain on the health system and the supply chain affected the distribution of naloxone [6, 8] and other medications for opioid use disorder [17]. These disruptions coincided with potential COVID19 related disruptions to the usual distribution channels for illicit drugs, and the coinciding increase of synthetic opioids (e.g. fentanyl) and polydrug use [6, 9, 17–20]. In particular, disruption to the usual opioid supply chains resulted in reduced purity and related pricing changes to shifted consumption patterns in ways that increased the risk of overdose [9] Additionally, the general strain on health services during the early pandemic and the public health policy recommendations for social distancing and lockdowns are believed to have contributed to the opioid epidemic. Physical distancing and disruptions to income and daily routine affect mental health in ways known to

contribute to drug use and overdose, and to contribute to relapses for those in recovery [6, 7, 20, 21]. Isolation also contributes to more individuals using drugs alone, thus increasing the potential for overdose. Furthermore, strain on health services may limit availability of and access to treatment [6, 20].

Additionally, research in this area continues to document disproportionate impacts and increased fatality rates among racial and ethnic minority populations in the US. Analyses of ED records indicate that rates of OOD and OOD-related mortality had been rising in Black and Hispanic or Latino populations in the United States since 2015 [22, 23]. During the pandemic, rates further accelerated for both demographic groups [10, 23]. The rise in overdose mortality rates among Black individuals was particularly disproportionate, in 2020 rising above the overdose mortality rate for White individuals for the first time since 1999 [23]. Studies from EDs in Virginia, Philadelphia, Wisconsin, and Alabama have all shown higher opioid overdose and mortality rates for Black patients compared to White non-Hispanic patients during the pandemic [6, 10–12]. Further, though this demographic has received less attention in research literature, recent data has shown that the highest overall rate of overdose mortality in the United States was American Indian or Alaska Native individuals, who experienced a disproportionately higher mortality rate compared to white individuals in 2019 [23]. The sheer strain of the pandemic itself highlights the vulnerability and precarity of marginalized and minoritized populations [6, 24].

Similarly, regional studies of EDs in San Francisco [13], Kentucky [11], Maryland/Washington D.C [25], and a larger study of EDs across six other states all indicate increases in the rate of nonfatal OOD ED visits proportionate to all ED visits during 2020 over the previous year [1]. However, although the *count* of nonfatal ED visits increased in most of the systems in these studies, the increase was often not statistically significant [1]. The variability on display in reported nonfatal overdoses deserves further study, and is likely affected by a multitude of local, demographic, and community-based variables, including state health systems and policies (e.g., the presence or absence of refusal to transport EMS laws). Due to the variability from state to state and region to region in collecting and analyzing these data, it is necessary to continue to attend to regional variation and policies in understanding the changing shape of the opioid epidemic and response.

Methods

The primary aim of this study was to offer a comparative exploration of the effects of COVID-19 and associated public health measures on OOD events in three Texas counties. Along the way, we aim to provide insights about the extent to which twindemic analyses and related hypotheses apply to the counties studied. Specifically, the analysis presented here focused on Travis, Williamson, and El Paso Counties (See Fig. 1). These counties represent three markedly different areas of Texas and have significant variances in demographics, socio-economic status, urban-rural distributions, and COVID-19 impact. Travis County, where Austin is located, had a total population of 1,290,218 in 2020. The county is predominantly urban and majority White, with 32.6% of residents identifying as Hispanic or Latino in the 2020 census. Williamson County had a population of 609,006. It lies directly to the north of Travis County and is comprised of a mix of wealthy Austin suburbs and rural areas. The majority of residents are White, with 24.2% identifying as Hispanic or Latino. El Paso County has a population of 865,661. El Paso County includes both the City of El Paso and substantial rural areas. There are six US-Mexico border crossings in El Paso which have a combined north- and southbound 16.5 million personal vehicle 10.9 million pedestrian, and 1.3 million commercial vehicle crossings annually. El Paso is a majority-minority county with 82.6% of its residents identifying as Hispanic or Latino as of the 2020 census. Supplementary Material 1 includes detailed 2020 US Census demographics for each county. Finally, these counties are also useful comparators because they have substantially different COVID-19 profiles. Between March 6, 2020 and December 31, 2020, the per 100,000 resident COVID-19 mortality rate was 39.08 in Williamson County, 46.5 in Travis County, and 244.44 in El Paso County.

For the purposes of this study, we asked EMS records providers to conduct a structured query of all EMS encounter records for the two-year period on either side of March 14, 2020 (the date Governor Greg Abbot declared a state of emergency and started implementing public health restrictions). This broad-based query looked for a wide range of key terms that might indicate an OOD event. These included known opioid products, language related to overdoses, altered mental status, and naloxone administration. A complete list of filters is available in Supplementary Material 1. Data used in this study included call nature, primary impressions, chief narrative, chief complaint, prescription history, diagnostic history, race/ethnicity, gender and disposition.

OOD event identification

While EMS records can be particularly useful for understanding fatal and non-fatal OOD events, they present a particular challenge for identifying those events in the first place. EMS systems do not use ICD-10 or other recognized diagnostic codes like those found in ED records. The available data also indicates that EMS call center records and presumptive proxies like naloxone

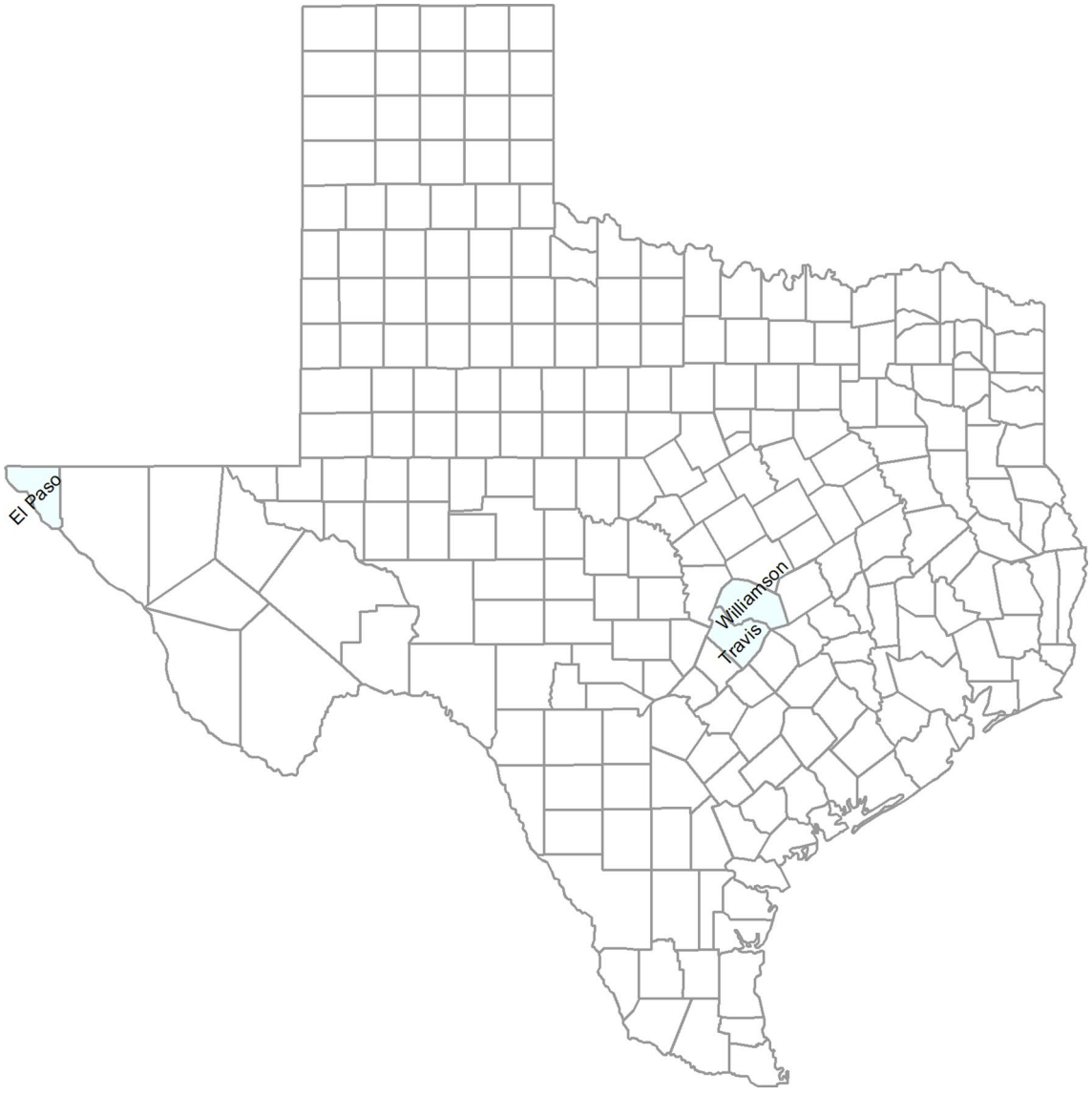

Fig. 1 Map of Texas with Williamson, Travis, and El Paso counties highlighted

administration are unreliable for accurately determining an OOD event has occurred [26, 27]. Therefore, our analysis makes use of a previously published supervised machine-learning system designed to identify OOD events in EMS records [26]. The system works by identifying and counting a list of potential overdose and opioid key words in chief complaint, chief narrative, primary impressions, full diagnostic history, and medications history sections of the EMS record. Keyword frequencies by field are then used to predict whether or not the event was an OOD. The keyword flagging approach outperformed alternative candidate approaches including feature engineering using term frequency-inverse document frequency (TFID) and vector embeddings from the Cui2Vec concept model which was created using the Unified Medical Language System. The flagging approach was tested against ground truth annotations provided by harm reduction paramedics and supporting annotators. Multiple machine learning algorithms were compared, and the most performant system achieved an AUROC of 0.93 (95% CI: 0.89–0.96) using the flags feature engineering approach and the XGBoost algorithm.

Metadata analysis

For each county we conducted an analysis of the accompanying OOD event metadata. Data were divided into two primary analytic periods the Pre-COVID Restrictions (Pre-CR) and public health restrictions (PHR) time frames. On March 2, 2021(just shy of one year after the Texas COVID-19 emergency declaration and establishment of public health restrictions), Governor Abbot ended all pandemic restrictions in the state. We

Table 1 Inter-rater reliability by each coding category

Coding category	Inter-rater reliability (k)
Social context	0.93
Event location	0.89
Housing insecurity	1.0
Naloxone administration	0.89
History of substance use	0.89
History of substance use treatment	1.0
OOD Intent	0.93
Substance profile	0.84

subsequently evaluated any potential changes in county-level OOD incident rates by year-long period and by month. We also evaluated the data for any Pre-CR vs. PHR changes in the proportion of OOD events by gender or race/ethnicity. Notably the records collected for this study do not disaggregate race and ethnicity data. All three county-level EMS services include race and ethnicity as a single variable. Finally, we evaluated if there were any changes in the proportion of OOD events by reported disposition (dead on scene, treated on scene, transport to tertiary care, transport refused).

Content analysis

In addition to the metadata analysis, we conducted a directed content analysis of the collected chief narratives [28]. Target coding categories included social context (alone or in a group), event location (residence, hotel, public), housing status (secure, insecure, unhoused), naloxone administration (self-administered, community-administered), history of substance use (overdose history, use history), history of substance use treatment (treatment history, loss of treatment access), OOD intent (intentional or accidental), substance profile (mono-opioid or polysubstance). A complete list of coding categories and possible values is available in Supplementary Material 1. Content codes were identified in consultation with the prior literature on the twindemic. Specifically, we sought to evaluate if previous suggestions about key factors in the twindemic might apply to this dataset. In all cases, this study uses a manifest coding approach. That is, we sought to code what was *stated* in the EMS record. Our application of the coding protocol relied both on what was documented directly by EMS and information quoted or summarized from patients or bystanders.

In order to evaluate inter-rater reliability, two members of the research team conducted an initial round of coding on 50 chief narratives. We used the IRR package in R to establish inter-rater reliability with Cohen's k. Initial inter-rater reliability proved to be >0.80 for seven of the eight categories, the only exception being the Substance Profile category. After discussion and norming of disagreements, the rating team conducted a second round of inter-rater reliability over a second set of 50 narratives (for a total of 100 narratives), achieving inter-rater reliability>0.80 across all categories, as demonstrated in Table 1. With sufficient reliability established, each of the remaining records was coded by a single rater.

Data quality analysis

Finally, we also conducted a brief EHR data quality analysis. This involved performing two assessments. First, we compared missing data rates across each of the identified time periods, Pre-CR vs. PHR. Secondly, for the free text entry EHR fields, we also evaluated if there were statistically significant changes in text length (measured by number of characters) between the two specified time frames.

Results

The initial search query identified a total of 80,229 possible EMS encounters for analysis. Within these 1170 OOD events were identified across the three-county dataset. This includes 874 in Travis County, 242 in El Paso County, and 54 in Williamson County. Each county experienced modest changes in EMS calls for OOD events between the Pre-CR and PHR time periods. Travis County's OOD event rate declined from 454 to 420. El Paso's increased from 103 to 139, and Williamson County's increased from 23 to 31. Table 2 provides a county-by-county overview of possible and AI-identified OOD events. The table also provides equality of proportions text data showing that although absolute values of OODs changed between Pre-CR and PHR time periods, there was no significant difference in OOD rates as a percentage of possible OOD events. Additionally, Fig. 2 provides an overview of monthly OOD rates by county. The plot shows relatively consistent monthly rates across the two-year period, with expected seasonal variations [29–31]. In order to assess if COVID and/or COVID public health restrictions had a meaningful and measurable effect on OOD rates, we conducted a paired mean difference estimation for comparator months across all three counties. Since data were pooled by calendar month, and the Pre-CR and PHR threshold is March 14, 2020, March comparisons were excluded. For available paired months

Table 2 Possible and AI-identified OOD events by county

County	Pre-CR possible	PHR possible	Pre-CR -PHR Δ	Pre-CR OOD	PHR OOD	χ^2	*p*
El Paso	5519	5817	298	103 (1.87)	139 (2.39)	3.47	0.06267
Travis	33,365	27,901	-5464	454 (1.36)	420 (1.51)	2.16	0.14182
Williamson	3521	4106	585	23 (0.65)	31 (0.75)	0.15	0.69544

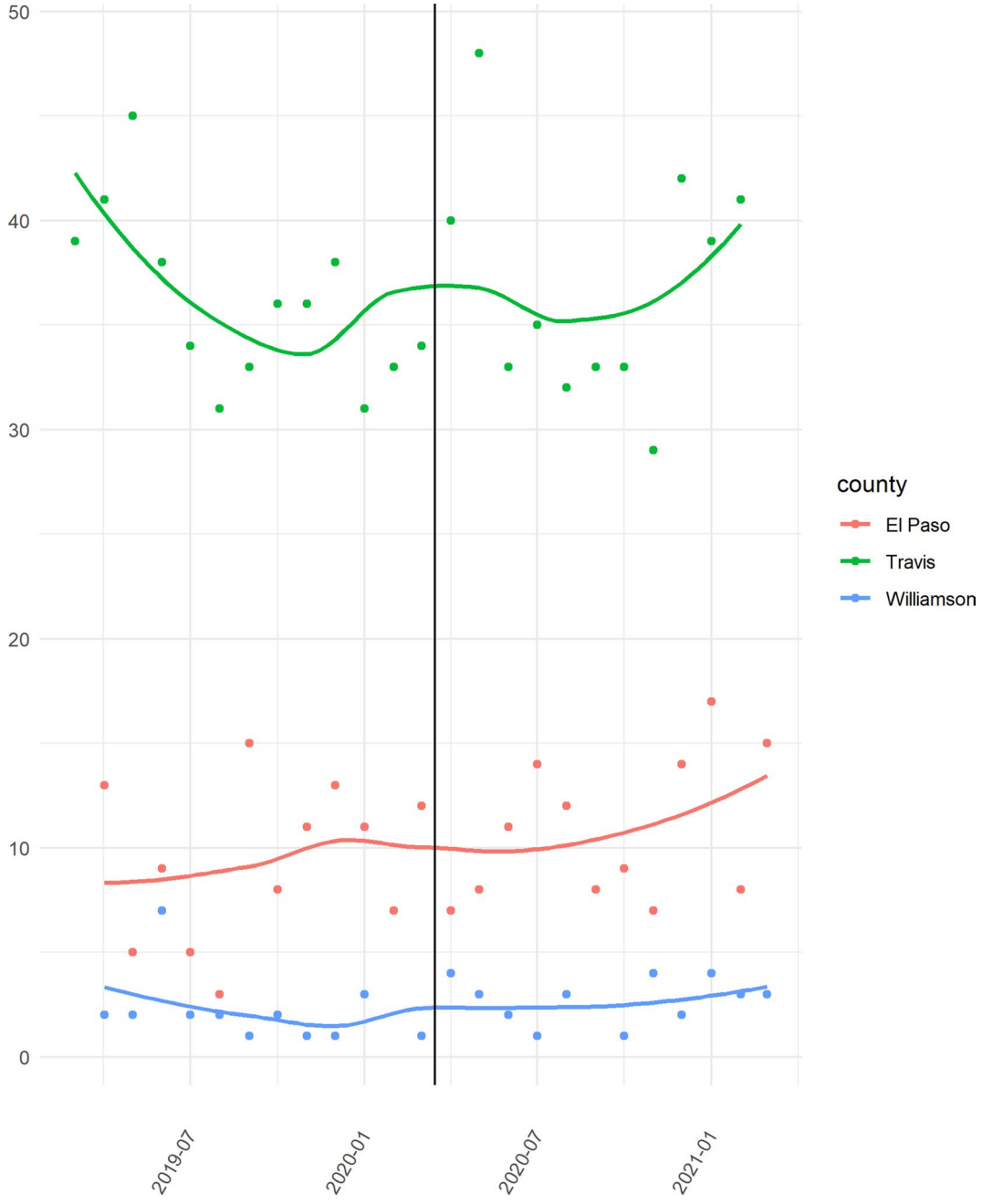

Fig. 2 Monthly OOD rates by county with loess regression for trendline

across all three counties, the estimated mean difference is 0.423 OOD events (95% CI: -8.5 to 9.308). With a negligible point estimate and a 95% confidence interval that includes 0 and a p-value of 0.9561, we interpret these findings to indicate there is no measurable or meaningful difference on monthly OOD rates between the two time periods. See Fig. 3 for details. In what follows, we describe changes in OOD events across the two one-year periods (Pre-CR vs. PHR). Our analysis indicates noteworthy differences between counties, and so we have disaggregated results accordingly.

Travis county

On the whole, OOD EMS encounters declined between the Pre-CR and PHR periods in Travis County. Specifically, a 7.49% decrease from 454 to 420 was observed. The observed decline is consistent across reported patient genders. Between the Pre-CR and PHR periods, the number of OOD events experienced changed from 123 (27.09%) to 116 (27.62%) for women and 331 (72.91%) to 304 (72.38%) for men. Two-sample equality of proportion tests were used to assess the significance of these declines and neither change was statistically significant

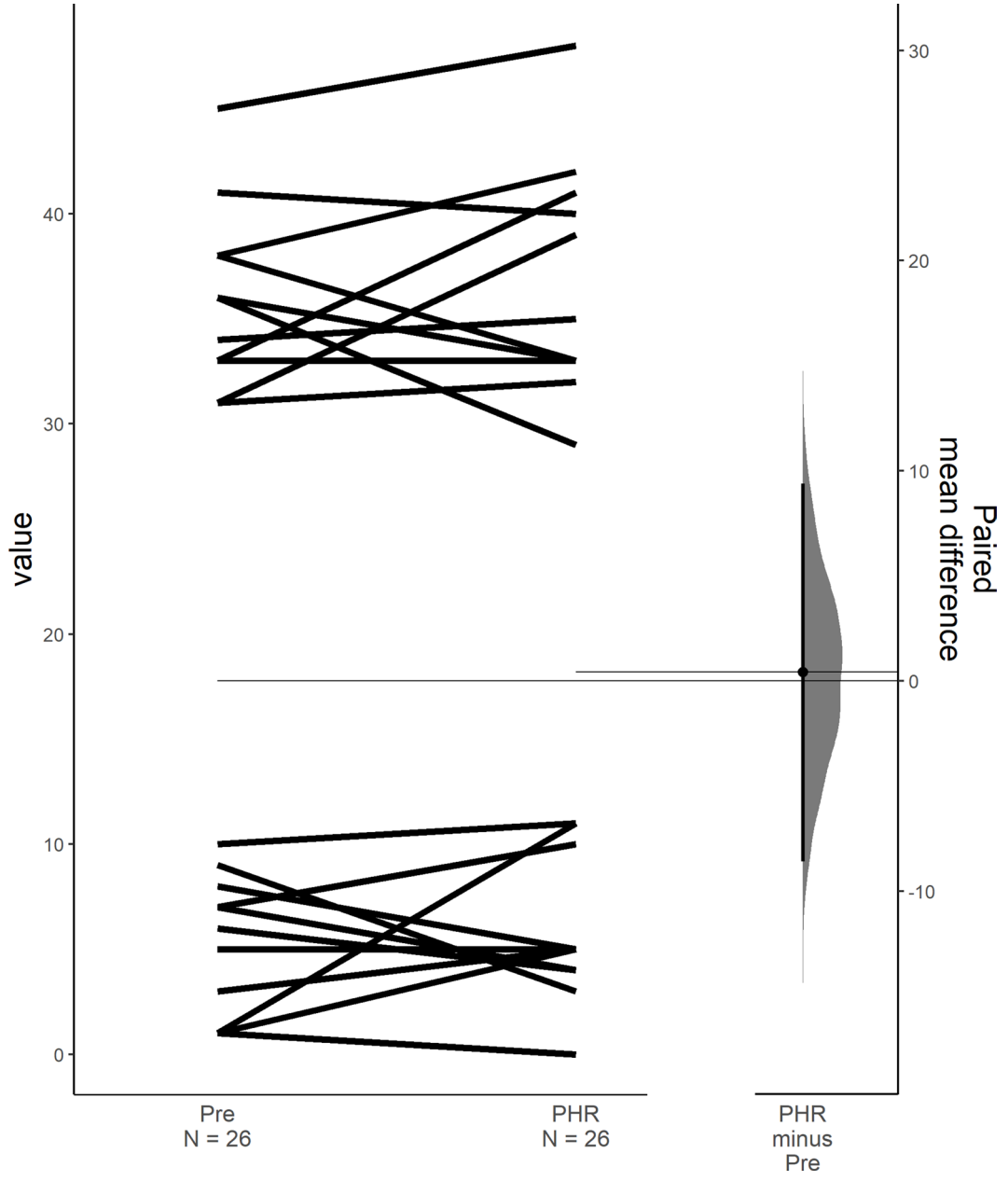

Fig. 3 Paired mean difference estimation for pre-CR and PHR months (excluding march comparisons)

at the $p<0.05$ level. Changes in OOD event rates by ethnicity were, however, more variable. OOD rates declined from 331 (72.91%) to 280 (66.67%) among patients listed as White in EMS records and likewise from 46 (10.13%) to 34 (8.1%) for patients listed as Black or African American. Neither decline was statistically significant. A non-significant increase in OOD rates among patients identified as Hispanic or Latino was also observed. The change was from 65 (14.32%) to 78 (18.57%). The only significant change in reported ethnicity was an increase in cases where the patient's race was not listed. The rate of missing race data increased from 11 (2.42%) to 34 (8.1%) between the two periods, $\chi^2=8.25$, $p=0.004$. There were also several observed changes in disposition rates between the Pre-CR and PHR periods. The number of patients transported to tertiary care declined from 396 (85.02%) to 327 (77.86%). This decline in transport rates was significant at $\chi^2=6.98$, $p=0.0082$. A significant increase in transport refusals was also observed between the two time periods. The incidence of patients declining transport to tertiary care increased from 65 (14.32%) to 90 (21.43%), $\chi^2=7.08$, $p=0.0078$. See Table 3 for complete demographic and disposition analysis details.

Table 3 Travis county Pre-CR and PHR metadata rates

Category	Variable	Pre-CR	PHR	χ^2	*p*
Gender	Female	123 (27.09)	116 (27.62)	0.01	0.92151
	Male	331 (72.91)	304 (72.38)	0.01	0.92151
Race	<None Reported>	11 (2.42)	28 (6.67)	8.25	0.00408*
	Black or African American	46 (10.13)	34 (8.1)	0.86	0.35447
	Hispanic or Latino	65 (14.32)	78 (18.57)	2.58	0.10802
	White	331 (72.91)	280 (66.67)	3.75	0.05287
	Asian	1 (0.22)	0 (0)	0	1
Disposition	Pronounced Dead on Scene	3 (0.66)	3 (0.71)	0	1
	Transport Refused	65 (14.32)	90 (21.43)	7.08	0.00778*
	Transported	386 (85.02)	327 (77.86)	6.98	0.00823*

*Statistically signifcant at the < 0.01 level.

Table 4 Travis county Pre-CR and PHR narrative and complaint details

Category	Variable	Pre-CR	PHR	χ^2	*p*
Social context	Alone	187 (41.19)	135 (32.14)	7.29	0.00694
Event location	Facility	47 (10.35)	28 (6.67)	3.32	0.0683
	Home	181 (39.87)	235 (55.95)	21.99	0
	Hotel	27 (5.95)	19 (4.52)	0.62	0.43
	Private	26 (5.73)	14 (3.33)	2.34	0.12608
	Public	173 (38.11)	124 (29.52)	6.78	0.00919*
Housing insecurity	Insecure	68 (14.98)	32 (7.62)	10.95	0.00094*
	Unhoused	6 (1.32)	4 (0.95)	0.04	0.84581
Naloxone	Community	46 (10.13)	34 (8.1)	0.86	0.35447
	Self	14 (3.08)	26 (6.19)	4.14	0.04196*
Use history	Use	299 (65.86)	238 (56.67)	7.4	0.00653*
	Overdose	38 (8.37)	32 (7.62)	0.08	0.77645
Treatment history	Loss	1 (0.22)	3 (0.71)	0.34	0.56221
	Treatment	71 (15.64)	57 (13.57)	0.59	0.44253
OOD intent	Accident	430 (94.71)	404 (96.19)	0.78	0.37787
	Suicide	23 (5.07)	16 (3.81)	0.54	0.46237
Substance profile	Mono	209 (46.04)	212 (50.48)	1.55	0.21312
	Poly	151 (33.26)	99 (23.57)	9.56	0.00199*
	Unsure	94 (20.7)	109 (25.95)	3.08	0.0792

*Statistically signifcant at the < 0.01 level.

Table 4 provides a comprehensive overview of results from the qualitative analysis of narrative and complaint data. Noteworthy situational changes include a decline in the number of OOD events where the patient was alone, an increased likelihood that OOD event would occur at the patient's residence, and an increased likelihood that the person experiencing an overdose would self-administer naloxone. The rate of OODs that occurred while the patient was alone declined from 187 (41.19%) to 135 (32.14%), $\chi^2=7.29$, $p=0.0069$. OOD event occurred more frequently in places identified as the patient's primary residence with a change from 181 (39.87%) to 235 (55.95%), X2 = 21.99, $p=0$. Self-administration of naloxone increased from 14 (3.08%) to 26 (6.19%), $\chi^2=4.14$, $p=0.042$. We also observed two changes in EMS documentation. EMS records were less likely to indicate whether a person experiencing an overdose was housing insecure and were less likely to note the event's substance profile. Reports on housing insecurity declined from 68 (14.98%) to 32 (7.62%), $\chi^2=10.95$, $p=0.0009$. Reports of polysubstance use declined from 151 (33.26%) to 99 (23.57), $\chi^2=9.56$, $p=0.002$.

Table 5 El Paso county Pre-CR and PHR metadata rates

Category	Variable	Pre-CR	PHR	χ^2	*p*
Gender	Female	26 (25.24)	36 (25.9)	0	1
	Male	77 (74.76)	103 (74.1)	0	1
Race	<None Reported>	38 (36.89)	58 (41.73)	0.39	0.53062
	Black or African American	3 (2.91)	1 (0.72)	0.66	0.41608
	Hispanic or Latino	48 (46.6)	72 (51.8)	0.45	0.50323
	White	13 (12.62)	8 (5.76)	2.71	0.09996
	White, Hispanic or Latino	1 (0.97)	0 (0)	0.02	0.88018

El Paso

In the Pre-CR year of the study, there were 103 EMS responses to OODs. This increased to 139 in the year following the implementation of pandemic protocols in Texas. The proportion of overdoses by gender did not change significantly with approximately 75% male and 25% female in each year. Likewise, there were no significant changes in OOD proportions by race with around 50% of OODs experienced among Hispanic or Latino patients, approximately 40% experienced by patients with an unreported race, and less than 13% among other ethnic groups. Data provided for this study from El Paso did not include patient disposition, and so it is not provided here. Complete results of the El Paso metadata analysis are available in Table 5.

Situational and reporting variables extracted from chief narrative and chief complaint sections were also largely consistent between each year. There was a significant reduction in reports of housing insecure OOD patients from 8 (7.77%) to 1 (0.72), $\chi^2=6.36$, $p=0.0117$. There was also an increase in the rate of EMS records that did not identify whether the event was caused by a single or a polysubstance drug use, 19 (18.45%) vs. 55 (39.57%), $\chi^2=11.46$, $p=0.00071$. Complete results are available in Table 6.

Table 6 El Paso county Pre-CR and PHR narrative and complaint details

Category	Variable	Pre-CR	PHR	χ^2	*p*
Social context	Alone	45 (43.69)	49 (35.25)	1.44	0.23085
Event location	Facility	4 (3.88)	7 (5.04)	0.01	0.91
	Home	53 (51.46)	69 (49.64)	0.02	0.88127
	Hotel	2 (1.94)	3 (2.16)	0	1
	Private	9 (8.74)	8 (5.76)	0.41	0.52005
	Public	35 (33.98)	52 (37.41)	0.17	0.67869
Housing insecurity	Insecure	8 (7.77)	1 (0.72)	6.36	0.0117*
	Unhoused	2 (1.94)	2 (1.44)	0	1
Naloxone	Self	1 (0.97)	1 (0.72)	0	1
Use history	Use	41 (39.81)	49 (35.25)	0.35	0.55503
	Overdose	3 (2.91)	1 (0.72)	0.66	0.41608
Treatment history	Treatment	0 (0)	4 (2.88)	1.5	0.22013
OOD intent	Accident	97 (94.17)	135 (97.12)	0.66	0.41653
	Suicide	6 (5.83)	4 (2.88)	0.66	0.41653
Substance Profile	Mono	63 (61.17)	65 (46.76)	4.36	0.0367
	Poly	21 (20.39)	19 (13.67)	1.48	0.22384
	Unsure	19 (18.45)	55 (39.57)	11.46	0.00071*

*Statistically signifcant at the < 0.01 level.

Table 7 Williamson county Pre-CR and PHR metadata rates

Category	Variable	Pre-CR	PHR	χ^2	*p*
Gender	Female	9 (39.13)	9 (29.03)	0.24	0.62662
	Male	14 (60.87)	22 (70.97)	0.24	0.62662
Race	<None Reported>	0 (0)	18 (58.06)	17.5	0.00003*
	Hispanic or Latino	1 (4.35)	1 (3.23)	0	1
	White	22 (95.65)	12 (38.71)	16	0.00006*
Disposition	Assist, unit[a]	1 (4.35)	1 (3.23)	0	1
	Patient treated, released (per protocol)	3 (13.04)	3 (9.68)	0	1
	Transported	19 (82.61)	27 (87.1)	0.01	0.94282

[a]"Assist, unit" indicates that multiple units were called to the scene, and that another unit was responsible for transport

*Statistically signifcant at the < 0.01 level.

Williamson county

In the year prior to the implementation of COVID mitigation protocols, Williamson County EMS responded to 23 cases identified as OODs. This number increased to 31 after March 15, 2020. The proportion of OODs by gender did not change significantly. However, there was a statistically significant reduction in OODs among White patients, 22 (95.65%) to 12 (38.71%), $\chi^2=16$, $p=0.00006$. In Williamson County, we also observed an increase in cases where the patient's race was not documented, from 0 (0%) to 18 (58.06%), $\chi^2=17.5$, $p=0.00003$. There were no significant changes in patient disposition following OOD calls. Complete demographic and disposition results are available in Table 7. Narrative and complaint details are also available in Table 8. However, there were no significant changes in frequencies for any assessed variable.

Table 8 Williamson county Pre-CR and PHR and complaint details

Category	Variable	Pre-CR	PHR	χ^2	*p*
Social context	Alone	1 (4.35)	7 (22.58)	2.18	0.13951
Event location	Facility	1 (4.35)	3 (9.68)	0.05	0.831
	Home	19 (82.61)	17 (54.84)	3.42	0.0645
	Hotel	2 (8.7)	3 (9.68)	0	1
	Private	1 (4.35)	5 (16.13)	0.85	0.35531
	Public	0 (0)	3 (9.68)	0.87	0.35007
Housing status	Insecure	1 (4.35)	1 (3.23)	0	1
Comm. Naloxone	Com	3 (13.04)	2 (6.45)	0.12	0.72511
	Self	1 (4.35)	1 (3.23)	0	1
Use history	Use	7 (30.43)	9 (29.03)	0	1
	Overdose	3 (13.04)	4 (12.9)	0	1
Treatment history	Treatment	3 (13.04)	3 (9.68)	0	1
OOD intent	Accident	15 (65.22)	28 (90.32)	3.7	0.05443
	Suicide	8 (34.78)	3 (9.68)	3.7	0.05443
Substance profile	Mono	9 (39.13)	6 (19.35)	1.68	0.19459
	Poly	8 (34.78)	10 (32.26)	0	1
	Unsure	6 (26.09)	15 (48.39)	1.9	0.16761

Table 9 Missing data rates pre-CR vs. PHR

County	Category	Pre-CR	PHR	χ^2	*p*
Travis	Nature	1 (0.22)	0 (0)	0	1
	Rx reference list	56 (12.33)	45 (10.71)	0.41	0.52034
	Full Hx and Dx	33 (7.27)	33 (7.86)	0.04	0.841084
Williamson	Chief complaint	0 (0)	1 (3.23)	0	1
El Paso	Rx reference list	69 (66.99)	92 (66.19)	0	1
	Full Hx and Dx	49 (47.57)	91 (65.47)	7.05	0.00791*

*Statistically signifcant at the < 0.01 level.

Data quality analysis

The vast majority of the collected EHR records were complete, without missing entries. Nevertheless, as noted above, we observed increases in non-reporting of race data in all three counties. These increases were statistically significant in Travis and Williamson Counties. Our data quality analysis further identified additional missing data in the following EHR fields: call nature (Travis County), prescription reference list (Travis and El Paso Counties), chief complaint (Williamson County), and full history and diagnoses (Travis and El Paso Counties). As Table 9 details, there were generally no statistically significant changes in missing data rates, with the exception of El Paso County that showed a substantial increase in missing prescription reference list entries, from 47.57 to 65.57% ($\chi^2=7.05$, $p=0.00791$). We further compared average text length (number of characters) for the primary free-text-entry fields (excluding missing values): primary impressions, full history and diagnosis,

chief complaint, and chief narrative. Average text length declined for all categories in Travis County, but only the change in primary impressions was statistically significant, t(871.6)=2.5, p=0.011195. Average text length increased for all fields in Williamson County, with only chief complaint being statistically significant, t(51.0 = -2.1, p=0.03908. Text length changed negligibly and non-significantly across all fields in El Paso County. Full results are available in Table 10.

Discussion

The data presented here continue to support emerging findings that there are substantial geographic differences in how COVID-19 and related restrictions may have affected opioid use. While two counties in the dataset showed a modest increase in OOD EMS responses during the PHR period, one showed a decline. Importantly, none of these changes in OOD response rates were statistically significant as a percentage of possible OOD events, and the observed changes in by-month comparisons were also not significant. Subsequent demographic analyses by county did not show substantial differences by race/ethnicity or gender. However, it is important to note that many EMS providers, including those included in this study, use EHR systems that have a single data field for race and ethnicity. In practice, this means that categories like White, African American, and Hispanic are treated as mutually exclusive. It is possible that an analysis using US Census categories might find different patterns. However, these data have not been collected and are not available. Furthermore, future research might refine the analyses presented here by exploring OOD response rates in the context of overall call volume or response rates. Additionally, we did not observe many significant differences in outcomes by reported disposition. The only observed changes of note were a significant increase in transport refusal (and a corresponding decrease in transport to tertiary care) in Travis County during the PHR period. Additionally, many of the specific hypotheses regarding the effects of COVID-19 and subsequent public health restrictions did not seem to apply to these data. In El Paso and Williamson Counties, changes in OOD-related EMS incident reports while alone were not significant. In Travis County, we observed a statistically significant reduction in the rate of OOD-involved EMS response incidents where the patient was alone. Travis County OOD events also showed a significant increase in the likelihood that the event would occur in the patient's stable residence. It has been suggested in the literature that diminished OOD outcomes may be associated with [1] disruptions in naloxone supply chains during the pandemic and [2] increased social isolation prevented bystanders from administering naloxone [8]. The data presented here do not substantially support these suggestions for the studied counties. Overall naloxone administration rates remained consistent in all three counties. While Travis County had a modest increase in self-administered naloxone rates, there was no corresponding statistically significant decrease in community-administered naloxone.

All-in-all the data presented here problematize suggestions that COVID-19 public health interventions had an adverse impact on OOD rates in the selected counties. While there were observed increases in EMS responses for OOD events in two counties, there was a noticeable decline in responses in Travis County. While stay at home orders may have increased social isolation in some cases and potentially driven drug use, the public health response to COVID-19 also included significant efforts at economic relief. The PHR period corresponded to national declines in homelessness rates, which have been directedly tied to economic interventions such as rent assistance [32]. Additionally, between 2020 and 2021, Travis County saw a modest decline in overall housing insecurity rates based on point-in-time estimates [33]. This corresponds to the observed decline in EMS

Table 10 Average text length pre-CR vs. PHR

County	EHR field	Pre-CR	PHR	t	df	*p*
Travis	Primary impressions	21.7	197	2.5	871.6	0.01195*
	Full Hx and Dx	41.6	39.5	0.8	791.4	0.44028
	Chief complaint	16	16.3	-0.4	866.9	0.67066
	Chief narrative	1618.1	1567.7	0.9	859.9	0.35358
Williamson	Primary impressions	20.9	21.9	-0.8	41.7	0.41496
	Full Hx and Dx	37.0	39.3	-0.2	48.7	0.82955
	Chief complaint	13.3	17.4	-2.1	51.0	0.03908*
	Chief narrative	706.6	795.8	-1.2	34.5	0.22692
El Paso	Primary impressions	29.6	30.1	-0.8	181.8	0.40839
	Full Hx and Dx	47.2	42.6	0.7	95.6	0.49476
	Chief complaint	13.9	12.7	1.1	226.5	0.27305
	Chief narrative	1735.7	1853.5	-0.7	216.2	0.49715

*Statistically signifcant at the < 0.01 level.

responses to OOD events with unhoused patients. An important limitation of these findings is that while these data indicate an overall reduction in OOD-involved EMS encounters, CDC vital statistics for all fatal drug overdoses indicate a steady increase during the same period [34]. These data suggest two possible hypotheses that warrant further investigation. First, available data indicate that the COVID-19 pandemic corresponded with broad reductions in healthcare services utilization [35]. People experiencing an overdose may have been less likely to call EMS given fears of COVID-19 infection. This possibility is potentially supported by the increase in refusal of transport observed in Travis County. A second hypothesis is that there may have been unknown effects on drug use profiles during the pandemic. National attention to opioids may have resulted in unwarranted conclusions that opioids remained the primary driver of fatal overdoses. Indeed, emerging research indicates that there was increased difficulty obtaining opioids during the pandemic and that this corresponded with increased purchases from less trusted providers who may have been distributing fraudulent and adulterated products [9, 36]. Additional research should be conducted to further explore this issue.

One of the most notable findings in this analysis is an increase in missing data during the PHR period. We observed a significant decline in reporting patient race/ethnicity in Travis and Williamson Counties. There were likewise a significant increase in missing data under full history and diagnosis in El Paso County. Likewise, there was a statistically significant decrease in average text length for primary impressions in Travis County. While data quality declines are modest and inconsistent, they are most remarkable for Travis and El Paso Counties. Notably, these two counties had higher COVID mortality rates than Williamson County, which may partially explain the difference. It is well established that the COVID-19 pandemic was a source of substantial stress for first responders [37]. Additionally, it has been suggested that provider burnout associates with diminished quality of clinical documentation [38]. This is an issue that should be studied in greater detail across provider types and scopes of practice. While there is significant data available on the effects of electronic health records on provider burnout [39], additional research may need to be conducted on the effects of provider stress on the quality of documentation. There is some data available which suggests that COVID-related stress may have affected the way providers write about people who use drugs and corresponded with an increase in the use of stigmatizing language [40]. Similarly, these changes in documentation completeness may be evidence of known stressors on first responders during the worst stages of pandemic.

Conclusion

The overall goal of this study was to provide a detailed analysis of OOD-involved EMS encounters in three Texas counties before and during pandemic restrictions. The results presented add additional nuance to the scientific understanding of the so-called opioid-COVID-19 "twindemic." The data presented here further support emerging analyses that demonstrate substantial geographic differences in the experience of these twin public health emergencies. While data from other states and counties have shown changes in OOD rates alongside COVID-19 public health restrictions, similar patterns were not observed in El Paso, Travis, or Williamson County. It is possible that Travis and Williamson experienced differential impacts by race and/or ethnicity. However, opportunities to assess between-group differences in each county were stymied by significant decreases in documentation of patient race and ethnicity. These results point to issues in documentation quality, possibly as a result of systemic stressors on healthcare providers. Additional research should be conducted to evaluate the full scope of the issue and if it obtains in other localities. While the burnout and documentation quality findings in this paper are tentative, they do suggest that efforts to address future public health emergencies should be mindful of how first responder stress and burnout may diminish our ability to effectively evaluate pandemic effects and response quality. Additionally, the Travis County results provide additional data on mid-pandemic refusal of care which may have extended more fully to emergency medical services than previously realized. Furthermore, these results also indicate that drug use profiles may have shifted during COVID-19 and that the public health community should be careful about assumptions that opioids were the primary driver of increased overdose rates. Ultimately, the results of this study indicate that the analysis of EMS records may be an underutilized resource for understanding both the opioid epidemic and other public health emergencies. Such analyses can identify important local differences in response and outcome.

Abbreviations

OOD	Opioid overdose
EMS	Emergency Medical Services
CR	COVID Restrictions
PHR	Public Health Restrictions

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13011-024-00627-5.

Supplementary Material 1

Acknowledgements

The following EMS departments who provided data: Austin Travis County EMS, Williamson County EMS, and El Paso Fire Department.

Author contributions
SSG- Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing-original draft, review & editing; NS- Data curation, Formal analysis, Writing-original draft, review & editing; TBH- Data curation, Formal analysis, Writing-original draft, review & editing; KH- Data curation, Formal analysis, Writing-original draft, review & editing; KC- Conceptualization, Data curation, Methodology, Writing- review & editing; Funding.

Funding
This research was funded by a grant from the Texas Health and Human Services Commission, 1H79TI081729 to KC and National Institute on Drug Abuse, K23DA039037, to KC.

Data availability
Patient privacy regulations and human subjects research protection policies prohibit sharing the individual level data included in this study. Researchers wishing to access the data may contact the University of Texas at Austin Addiction Research Institute and secure access approval through the University of Texas at Austin Institutional Review Board. Data access must conform to ethical review and approved uses. Contact via: The University of Texas at Austin Addiction Research Center 3001 Lake Austin Blvd Austin, Texas 78703.

Declarations

Ethics approval
Ethics approval for this study was obtained from the Institutional Review Board (IRB) at The University of Texas at Austin. Study ID: 2019110056.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]The Addiction Research Institute, The University of Texas at Austin, 3001 Lake Austin Blvd., Suite 1.204, Austin, TX 78703, USA
[2]The Department of Rhetoric and Writing, The University of Texas at Austin, 208 W. 21st St, STOP B5500, Austin, TX 78712, USA
[3]The Moody College of Communication, The University of Texas at Austin, 300 W. Dean Keeton (A0900), Austin, TX 78712-1069, USA
[4]The Steve Hicks School of Social Work, The University of Texas at Austin, 1925 San Jacinto Blvd, Austin, TX 78712, USA

Received: 16 February 2024 / Accepted: 29 October 2024
Published online: 08 November 2024

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