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County and Demographic Differences in Drug Arrests and Controlled Substance Use in Maine

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ORIGINAL RESEARCH

County and Demographic Differences in Drug Arrests and Controlled Substance Use in Maine

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Introduction: The Diversion Alert Program (DAP) was established to curb misuse of drugs and help identify people who may need treatment for substance use disorder (SUD). Law enforcement compiled arrest data into a database accessible by health care providers. Our objectives were to identify regional and demographic differences in drug use and misuse in Maine.

Methods: All arrests (N = 11 234) reported to the DAP from 2013 to 2018 were examined by county and arrestee demographics, and classified into families (opioids, stimulants, sedatives). The Drug Enforcement Administration's Automation of Reports and Consolidated Orders System (ARCOS) tracks the distribution of controlled pharmaceuticals (Schedule II-III). Opioids were converted to oral morphine milligram equivalents (MMEs). County and zip-code maps were constructed.

Results: The most arrests per capita occurred in Androscoggin, Knox, and Cumberland Counties. Opioids were the most common drug class in arrests in all counties except Aroostook County, where stimulants were most common. Medical distribution of opioids varied. Although buprenorphine doubled, many prescription opioids (eg, hydrocodone, fentanyl, oxycodone) exhibited large (> 50%) reductions in distribution. Methadone was the predominant opioid statewide (56.4% of total MMEs), although there were sizable differences between regions (Presque Isle = 8.6%, Bangor = 78.9%). Amphetamine distribution increased by 67.9%.

Discussion: The DAP, a unique pharmacoepidemiological resource, revealed a 6-fold difference in drug arrests by county. Regional differences in methadone may be due to heterogeneities in methadone clinic distribution.

Conclusions: The decrease in most prescription opioids, but increase in prescription stimulants, may warrant continued monitoring to improve public health.

Keywords: demographic differences, arrests, Maine, opioids, stimulants

In the New England states, the morphine milligram equivalents (MMEs) prescribed per person were among the highest in the United States. In 2016, Maine was ranked fifth nationally at 1393 MME,

which increased to 2000 MME when opioid use disorder (OUD) medications, buprenorphine and methadone, were included.¹ Importantly, more than 80% of people who use heroin started with prescription opioids.² Over the past 2 decades, opioid prescribing patterns differed appreciably in the United States. In states such as Maine, West Virginia, Kentucky, prescribing rates in the late 1990s were 2.5 to 5.0 times higher than the national average for hydrocodone and oxycodone.³

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States with a higher median age, such as Maine, also used more prescription opioids in general.¹ Cumberland County, containing Maine's largest city of Portland, accounted for 60% more drug-related deaths from 1997 to 2002 than would be anticipated based on the population. This percentage indicates an ongoing issue that has been plaguing the region. Based on Maine's medical examiner reports, methadone, oxycodone, fentanyl, hydrocodone, and other prescription opioids were the drugs most often mentioned on death certificates in the last 2 decades.⁴ Drug fatalities in years as recent as 2019 continued to involve opioids in 84% of the cases. These fatal overdoses typically occurred with other substances, including fentanyl analogs, which have been on the rise since 2013.^{5,6} Innovative strategies are needed to address this ongoing public health crisis.

Maine had a novel database, the Diversion Alert Program (DAP), which originated in Aroostook County and was expanded statewide to improve communication between law enforcement and health care providers. The DAP included arrestee names, dates of birth, towns of residence, drug charges, implicated drugs, and arresting agency for adults whose arrest involved illicit substances, prescription medications, and non-prescription pharmaceuticals.⁷ As a point-of-care tool, this resource could be used to help identify patients who might have needed specialist (eg, pain, psychiatry, or addiction medicine) involvement. The DAP was also used as a pharmacoepidemiological source, with regular reports for 2014 through 2017.^{3,5,7,8,9} The predominant substances involved in arrests were heroin, cocaine and crack cocaine, buprenorphine, oxycodone, methamphetamine, alprazolam, clonazepam, marijuana, hydrocodone, fentanyl, amphetamine, α -pyrrolidinovalerophenone (or bath salts), and gabapentin. Possession accounted for most (three-fifths) charges, followed by trafficking. Older adults (≥ 60 years old) had a significant and disproportionate percentage of their arrests involving oxycodone and hydrocodone.⁸ The annual reports showed that Cumberland and Androscoggin Counties led the state on population-corrected arrests.^{7,8}

The first objective of this study was to analyze nonmedical use of controlled substances at a county level as reported by the DAP. The second objective was to examine whether the arrest profile differed by arrestee demographics, specifically

their biological sex and age. The third objective was to use a comprehensive data source, the Drug Enforcement Administration's (DEA) Automation of Reports and Consolidated Ordering System (ARCOS) to determine regional changes in medical use of controlled substances in Maine. Collectively, we aimed to identify which recreational and medical drugs and drug classes are of concern, and to reveal the demographic and regional profile of those at risk for substance misuse in Maine.

METHODS

Procedures

Two complementary data sources were used: the DAP and ARCOS. The sample included all arrests (N = 11 234) reported to the DAP from 2013, when the program expanded statewide, to March 2018, when the program ceased operation due to lack of funding. Local, state, and federal law enforcement agencies provided information. A de-identified spreadsheet containing information on age, sex, county of arrest (Supplemental Figure 1), substance, and offense was obtained. A prior study determined that, overall, possession accounted for 60.0% of arrests, followed by trafficking (24.5%), distribution (3.9%), and possession with intent to distribute (3.5%); however, this general pattern differed considerably by agent.⁹ Arrest data was classified by the arrestee's county of residence. State and county values were calculated for the following categories: total number of arrests, total population, percentage of county population arrested, percentage of arrests involving females, mean age of total arrests, percentage of arrests involving opioids or stimulants, most frequent federal drug schedule, and most common level (federal, state, county, or city) of arresting agency. For simplicity, county and city agencies are henceforth designated as "local." Additional information, including the processing steps for arrests involving multiple drugs, is available elsewhere.⁷

The DEA's ARCOS is a federal program created with the 1970 Controlled Substances Act that collects data (weight distributed in grams) of Schedule II and III substances distributed to pharmacies, hospitals, methadone treatment programs (referred to by the DEA as narcotic treatment programs), and providers.¹⁰ From 2008 to 2017, the program evaluated 13 opioid pain medications (oxycodone, fentanyl, morphine, hydrocodone, hydromorphone, oxymorphone, tapentadol, codeine, meperidine,

dihydrocodeine, sufentanil, remifentanil, and alfentanil), and 2 opioids used primarily for OUD (methadone and buprenorphine). The oral MME conversion factors (eg, tapentadol = 0.4, methadone = 10) are available elsewhere.³ The weights distributed of stimulants (eg, methylphenidate, amphetamines, lisdexamfetamine) and barbiturates (eg, pentobarbital, secobarbital) were also obtained. ARCOS was previously validated by comparing results for a single opioid with that obtained for the Maine Prescription Monitoring Program, which revealed a high correlation ($r = 0.985$).¹ Similarly, when classifying areas into high versus low stimulant use, ARCOS showed a high agreement (96.4%) with the California Prescription Monitoring Program.¹¹ Procedures were approved by the ethics committee of the University of New England.

Data analysis

The rate of arrests per county was determined by taking the total number of arrests by the years DAP was operational statewide (4.75), dividing that number by the population in 2015 (ie, the midpoint year)¹¹, and multiplying that value by ten-thousand. Maine's population increased by 1.3% from 2008 to 2017. The percentage of all arrests involving females was calculated by dividing the number of female arrestees by the total number of arrests for each county. The percentage of arrests involving opioids or stimulants were calculated by dividing the number of arrests involving each drug class by the number of arrests in the county. ARCOS also reports drug distribution by the first 3 digits of the zip code. For simplicity, 039 = York, 040 = Kennebec, 041 = Portland, 042 = Lewiston, 043 = Augusta, 044 = Bangor, 045 = Boothbay Harbor, 046 = Bar Harbor, 047 = Presque Isle, 048 = Rockport, and 049 = Waterville. Geographic differences in the total MME for each opioid were expressed by dividing the highest percentages by the lowest percentages based on area (eg, 50% in county A/10% in county B = a 5-fold difference). The locations of the methadone clinics were obtained (August 2020). Relative to their peak year, arbitrary categories were interpreted as small (0% to 19.9%), medium (20.0% to 49.9%), and large ($\geq 50.0\%$) changes in controlled substance weight per year. County maps were generated with Microsoft Excel and QGIS.

RESULTS

Diversion Alert Program

Between 2013 and 2018, a total of 11234 drug-related arrests were reported to the DAP. A 5.6-

fold difference in the rate of arrests, corrected for population, occurred in Androscoggin County (26.9) relative to Piscataquis County (4.8). In Androscoggin County, 35.2% of the arrested population was female, compared to 42.5% in Lincoln County. The median age of arrestees differed by 6 years in Somerset County (35 years old) compared to Piscataquis County (29 years old). Among the 16 counties, 15 reported more opioid arrests than stimulant arrests. Counties with the greatest percentage of arrests involving opioids were Knox County (57.0%), Waldo County (56.8%), Kennebec County (55.9%), and Hancock County (55.6%). Stimulants accounted for fewer than one-eighth of arrests (11.7%) in Waldo and Lincoln Counties versus almost two-fifths (38.7%) in Aroostook County. Schedule II substances (e.g., cocaine) were most common in 13 (81.25%) counties. State agencies were responsible for most arrests in more than half (56.3%) of the counties (Table 1).

DEA's Automated Reports and Consolidated Orders System

Medical distribution of opioids, as defined by MME, increased in 2008 (2944.8 kg), peaked in 2010 (3207.5 kg), and declined through 2017 (2236.0 kg). A steep decline occurred from 2016 to 2017. Opioids primarily used for pain accounted for one-third of the total MME distributed in Maine in 2008 (32.4%). Distribution of analgesic opioids increased to 36.5% in 2012 before receding to 26.2% in 2017 (Figure 1, Panel A).

Figure 1, Panel B shows the dynamic changes in the distribution of individual opioids standardized to MME. Except for buprenorphine distribution, which doubled between 2008 and 2017, all other prescription opioids decreased over time. Relative to their peak years over the past decade, hydromorphone, methadone, codeine, oxycodone, and morphine have undergone moderate reductions in distribution. Oxymorphone, tapentadol, fentanyl, hydrocodone, and meperidine had large reductions. Lisdexamfetamine distribution increased 6.9-fold between 2008 and 2017 (9.8 kg). Figure 1, Panel C shows changes in other opioids during this period. Methylphenidate distribution had a small (-10.1%) decline since peaking in 2012 (157.0 kg) (Figure 1, Panel D). Amphetamine distribution greatly increased (+67.9%) between 2008 and 2017 (54.0 to 90.7 kg). Pentobarbital distribution remained relatively constant over the decade (79.9 kg in 2008 and 80.9 kg in 2017) (data not shown), whereas

Table 1. Maine Diversion Alert Program Arrests from June 2013 to March 2018

County	Number of total arrests	Total population size (2015)	Rate per 10K	% Female	Median age, y	% Total arrests involving opioids	% Total arrests involving stimulants	Most common federal class	Most common arresting agency
Androscoggin	1372	107 233	26.9	35.2	31	42.1	35.9	2	Local
Knox	430	39 855	22.7	31.6	31	57	17.9	2	State
Cumberland	3000	289 361	21.8	28.8	31	35.1	25.8	2	Local
Aroostook	693	68 824	21.2	27.9	31	27.6	38.7	2	State
Washington	313	31 625	20.8	41.9	35	47.3	18.9	2	Local
Lincoln	315	33 969	19.5	42.5	32	46	11.7	2	State
Penobscot	1400	152 692	19.3	29.5	31	44.7	29.6	2	Local
Waldo	352	39 155	18.9	32.4	31	56.8	11.7	2	State
Kennebec	932	119 980	16.4	35.6	31	55.9	24.7	1	Local
Hancock	417	54 659	16.1	35.7	32	55.6	20.4	2	State
Sagadahoc	210	35 113	12.6	28.1	32	42.4	17.6	1	State
Oxford	323	57 202	11.9	33.7	32	48.9	21.7	2	State
Somerset	285	50 745	11.8	25.6	35	51.2	27	2	Local
York	1038	201 169	10.9	32.5	31	54	22.5	1	State
Franklin	115	30 072	8.1	35.7	30	37.4	22.6	2	State
Piscataquis	39	16 935	4.8	35.9	29	51.3	20.5	2	Local

*Rate is the number of arrests per year divided by the population size in 2015 and multiplied by ten-thousand.

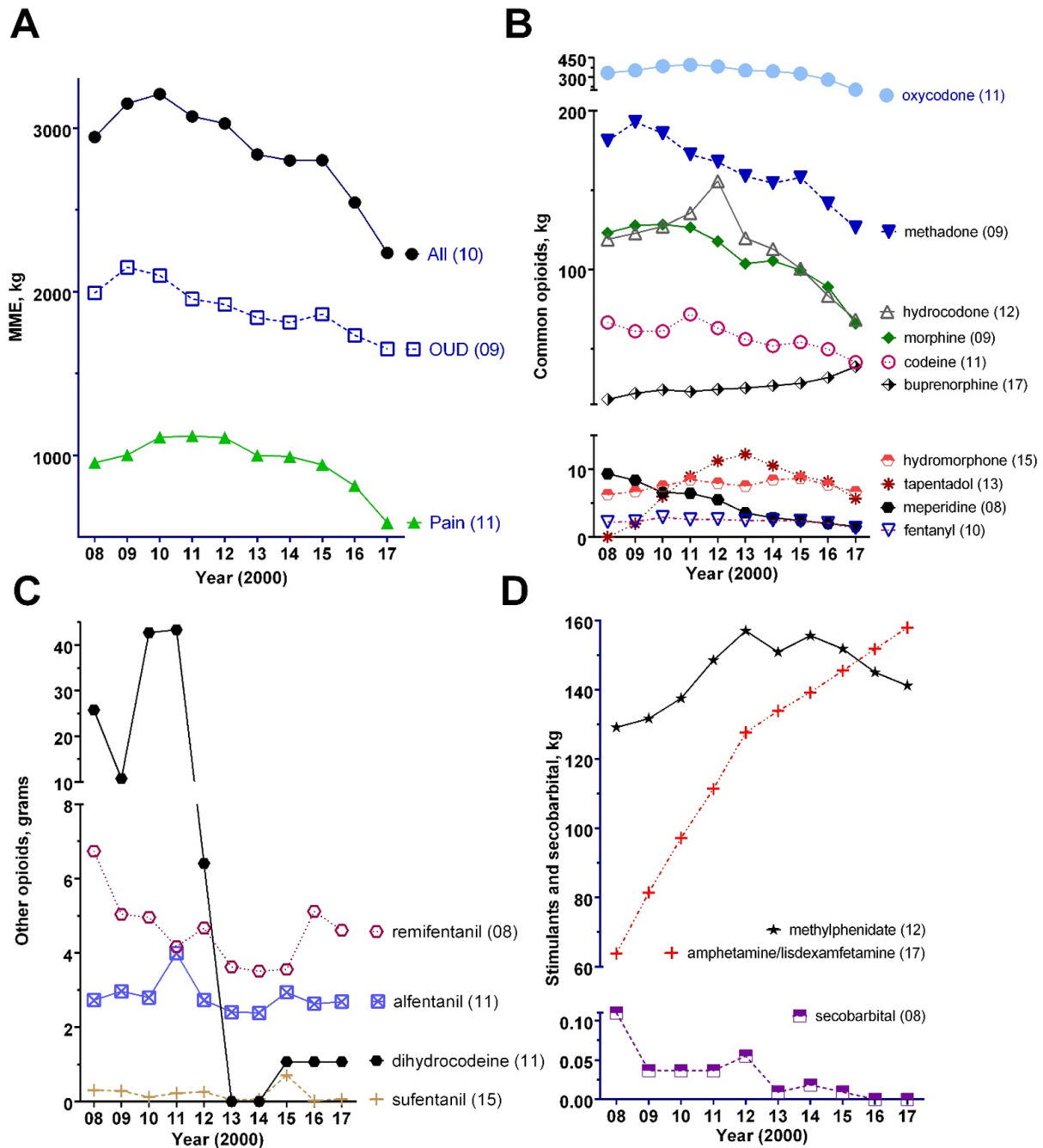


Figure 1. Distribution of Opioid Use. (Panel A) Total morphine milligram equivalents (MME) per year for opioids for pain (oxycodone, fentanyl, morphine, hydrocodone, hydromorphone, oxymorphone, tapentadol, codeine, and meperidine), opioid use disorder (OUD; methadone and buprenorphine), and all 11 agents. (Panels B-D) Raw weights of the most common opioids (Panel B), other opioids (Panel C), and stimulants and secobarbital (Panel D) as reported by the Drug Enforcement Administration's Automated Reports and Consolidated Orders System¹⁰ in Maine from 2008 to 2017. Percent change relative to the peak year is shown in parentheses.

secobarbital distribution precipitously decreased from rare (109.9 g in 2008) to unavailable (0.0 g in 2016 and 2017).

Further analysis was completed on 11 opioids, expressed as a percentage of the total MME, in 2017 by 3-digit zip code. This analysis revealed pronounced geographical variations relative to the location of methadone clinics (Figure 2). Methadone was the predominant opioid statewide, accounting for a 3-fold greater percentage of the total relative to buprenorphine (Figure 2, Panel

A). Opioids used primarily for OUD accounted for most opioids distributed in the Bar Harbor (75.0%), Rockland (85.2%), and Bangor (87.4%) zip codes, likely due to the presence of one or more methadone treatment programs in Rockland and Bangor. Methadone was responsible for one-fifth or less of opioids in York (21.0%), Boothbay Harbor (12.6%), and Presque Isle (8.6%) (Figure 2, Panel B). Zip-code level heterogeneities were 9.2-fold for methadone, 9.5-fold for morphine, 6.2-fold for fentanyl, 5.7-fold for oxycodone, and 4.9-

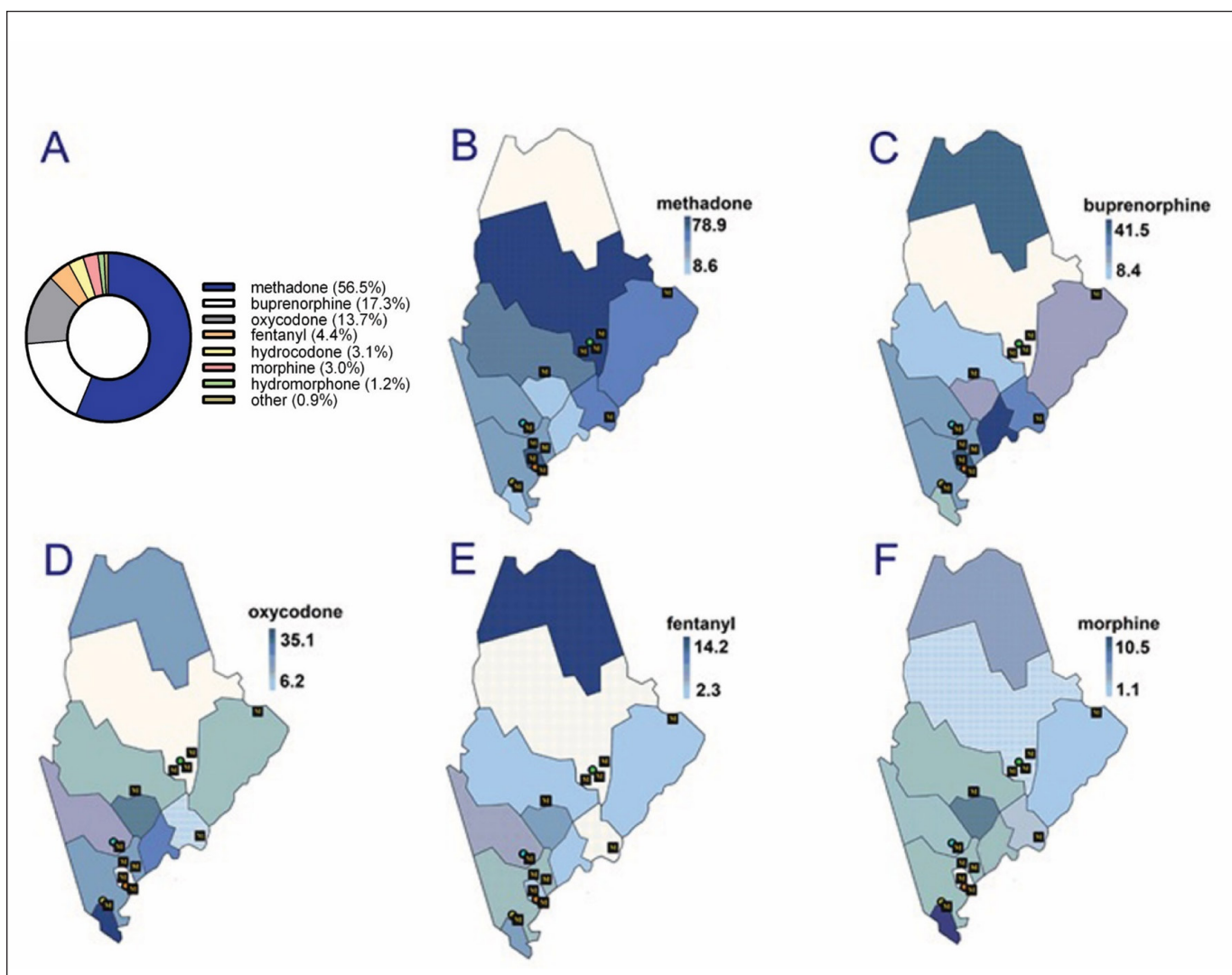


Figure 2. Geographical Variation in Opioid Use in Maine in 2017. Statewide percentage of the total morphine milligram equivalent by opioid is shown for the state overall (Panel A). The other category includes tapentadol, meperidine, oxymorphone, and codeine.

Statewide percentage of the total morphine milligram equivalent for specific opioids according by 3-digit zip codes (Panels B-F) are shown with color gradation reflecting the specific opioid noted. The location of methadone clinics (labeled M) are shown, as reported to the Drug Enforcement Administration's Automation of Reports and Consolidated Orders System.¹⁰

fold for buprenorphine. Hydrocodone accounted for an 8-fold greater portion of the total in Presque Isle (9.9%) relative to Portland (1.1%) (data not shown).

DISCUSSION

The first 2 objectives of this study were to examine county and demographic differences in controlled substance misuse in Maine. The rate of arrests showed 6-fold differences based on county. Except for Aroostook County, which was more impacted by stimulants, the state was very homogeneous in which drug class (opioids) was related to the most arrests. Examining controlled substance distribution over time revealed that prescription opioids peaked in 2010 and subsequently declined, particularly in 2016 and 2017. This study also determined that the geographical differences in which prescription opioids were most common by MME was associated with the location of methadone clinics. These facilities were not distributed uniformly statewide, as 25% of the state's total were in Penobscot County and 33% were in Cumberland County.¹³

This regional analysis extends our prior research that emphasized broader state-level patterns.⁹ The DAP provided information that complemented Prescription Monitoring Programs (PMPs) for patient care. However, the DAP was also invaluable for research and could complement other data sources, such as self-report from the National Household Survey on Drug Use and Health or Monitoring the Future, emergency room reports, and drug seizures.¹² A key theme in prior reports was the substantial diversity of substances implicated in arrests beyond the “usual suspects” of heroin, oxycodone, hydrocodone, illicit fentanyl, methamphetamine, and cocaine. Hundreds of arrests were related to benzodiazepines (eg, alprazolam, clonazepam), marijuana, and miscellaneous prescription pharmaceuticals that were non-controlled (eg, gabapentin, quetiapine).⁹

Our analysis revealed that almost 10-fold more arrests involved buprenorphine (812) than methadone (82). These data suggest the need to improve supervision and monitoring of prescribed buprenorphine, or the ongoing need for more access to buprenorphine prescribers. The disparity was striking given that, on an MME basis, methadone was distributed statewide over 3-fold more than buprenorphine. However, these data can be explained, in part, by considering the distribution of methadone for patients with OUD.

Due to federal regulations, addiction medicine providers typically dispense daily methadone doses onsite at methadone clinics. To date, Maine has 12 methadone clinics in 9 counties.¹³ These clinics contain providers who specialize in medically treating patients with OUD, especially methadone, and with providing counseling services.

A high rate of buprenorphine arrests may still be surprising, given the drug's pharmacology as a partial mu-receptor agonist. Buprenorphine has a safety profile that is considerably more favorable than that of methadone: LD₅₀ = 235 mg/kg (buprenorphine) vs 23 mg/kg (methadone) when given intravenously in rats.¹⁴ Yet, 11 000 poison-control reports still involved buprenorphine, primarily as a monotherapy product, among children and adolescents (< 19 years old) from 2007 to 2016.¹⁵ Buprenorphine was identified as a potentially contributing factor in 22 drug deaths in Maine in 2017.¹⁶ In other states, such as Wisconsin, law enforcement identified an increased number of cases of driving under the influence of buprenorphine, often with benzodiazepines.¹⁷ Although both methadone and buprenorphine are efficacious for OUD treatment, the provision of methadone for OUD is considerably more restricted than buprenorphine. A systematic review identified better retention in OUD treatment with methadone than buprenorphine/naloxone¹⁸, however buprenorphine prescribing practices have evolved significantly in the past decade. Methadone accounted for one-eighth of the total opioid MME in Presque Isle and Boothbay Harbor but three-quarters in Bangor and Portland. Methadone treatment programs in Maine increased from 9 in 2008 to 10 in 2017.¹⁰ Almost two-thirds of patients in opioid treatment programs resided in only 3 counties (Penobscot County = 33%, Cumberland County = 22%, and Washington County = 8%).¹⁹ Although there is room for improvement, Maine ranked second in the United States for the most waived physicians for buprenorphine per capita.²⁰

Pronounced reductions in opioid distribution over the past decade have been reported.²¹ Perhaps, more novel is the rate of change in opioid use, particularly from 2015 to 2017. Liberal practices in prescribing opioids during the 2000s was the unfortunate result of a confluence of factors.⁷ We suspect that the return to more judicious and evidence-based use of opioids, particularly minimizing use in patients with chronic non-cancer pain, may also reflect the convergence of multiple policy and incentive

changes at the federal, state, and local level. In January 2017, Maine's "An Act to Prevent Opiate Abuse by Strengthening the Controlled Substances Prescription Monitoring Program" took effect. This act was unusual for a state prescribing law because it included fiscal penalties for non-adherence. Maine had a significantly greater decrease in prescription opioids than several other New England (CT, MA, RI, VT) and mid-Atlantic states (NY, PA) that enacted similar opioid prescribing laws that lacked penalties.²¹ In the year that followed, between 2017 and 2018, drug-related deaths involving prescription opioids in Maine declined by 37%.¹⁶

Three other findings are noteworthy. The substantial increase in lisdexamfetamine and other amphetamine distribution extend earlier national data.⁷ ARCOS, and DAP, do not provide information about whether the original source of these stimulants was for attention deficit hyperactivity disorder in children or adults, obesity, post-traumatic brain injury, or another indication. The ratio of males to females for drug-related deaths in Maine was 2.51 to 1 in 2017⁵ and 2.45 to 1 in 2018.¹⁶ Among arrestees, the ratio was similar (2.14 to 1). Together with other arrest data, these findings indicate that sex differences in drug misuse may be gradually declining.¹⁷

Some strengths and limitations of these datasets are noteworthy. The DAP was unique to Maine and, to our knowledge, has not been emulated elsewhere, which precludes comparisons with other states. Reporting to the DAP was voluntary, and some agencies (eg, tribal police) infrequently submitted arrest information, which is a caveat in interpreting data in Table 1. Similarly, some individuals may have been arrested multiple times over a 6-year period. Although we cannot account for this factor in a de-identified research database, we do not believe it would impact southern versus northern Maine counties differently. It is important to emphasize that there are key differences between an arrest and a subsequent conviction, and data regarding conviction is unknown. It is also unknown how often field tests, whose specificity is questionable, were used to determine the presumptive substance identity.²² Finally, there is a potential for bias in DAP regarding populations that are more likely to be surveilled by law enforcement and subsequently arrested, such as those with a history of opioid overdose or diagnosed OUD. Socioeconomic

and racial disparities might also contribute to bias. Unlike PMPs, ARCOS is comprehensive in its coverage of Schedule II substances. ARCOS reports by substance weight instead of using perhaps more intuitive units of analysis, such as prescriptions. Methadone was the most prevalent opioid by MMEs.^{3,23} The 42 CFR Part 2 prevented methadone, when used by methadone treatment programs, from being entered into the state PMP results. Although arguably well-intentioned, this federal regulation is a key caveat when interpreting other pharmacoepidemiological research,^{8,24} and some have advocated that this regulation be updated.²⁵

CONCLUSIONS

The DAP was an important information-sharing and pharmacoepidemiological resource that was unique to Maine. This study identified a 6-fold difference in arrest rates by county. There were also sizable differences in drug arrests involving opioids and stimulants by county. A better understanding of the pronounced regional differences in prescription drug distribution and arrests may improve targeted public health interventions, including education and access to treatment. We are cautiously optimistic that the DAP could be integrated with PMPs and implemented in other states. Continued monitoring of trends in arrests, prescription use, and misuse is warranted. Further, limiting access by adolescents and persons with SUD to prescription opioid analgesics and other misusable substances should be a continued priority.

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