

Increasing Heroin, Cocaine, and Buprenorphine Arrests Reported to the Maine Diversion Alert Program

Kevin J Simpson, BS^{1*}, Matthew T Moran, MBS^{1*}, Kenneth L McCall, PharmD BCGP^{2*}, John Herbert, PharmD³, Michelle Foster, BA³, Olapeju M Simoyan, MD, MPH^{1,4}, Dipam T Shah, BS¹, Clare Desrosiers, MSW³, Stephanie D Nichols, PharmD, BCPS, BCPP^{2,5,6}, Brian J Piper, PhD MS^{1,7#}

*designated authors contributed equally

¹Geisinger Commonwealth School of Medicine, Scranton, PA 18509, USA

²University of New England, Portland, ME 04103, USA

³Diversion Alert, Houlton, ME 04730, USA

⁴Geisinger Marworth Treatment Center, Waverly, PA 18471

⁵Husson University School of Pharmacy, Bangor, ME 04401, USA

⁶Tufts University, Medford, MA 02155, USA

⁷Center for Pharmacy Innovations and Outcomes, Forty Fort, PA 18704 USA

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[#]Brian J. Piper, PhD, MS, Department of Medical Education, Geisinger Commonwealth School of Medicine, 525 Pine Street, Scranton, PA, 18510; Ph: (413) 347-7199; Fax: (570) 504-9660; psy391@gmail.com; bpiper@som.geisinger.edu

Abstract

Background: The opioid overdose crisis is especially pronounced in Maine. The Diversion Alert Program (DAP) was developed to combat illicit drug use and prescription drug diversion by facilitating communication between law enforcement and healthcare providers with the goal of limiting drug-related harms and criminal behaviors. Our objectives in this report were to analyze 2014-2017 DAP for: 1) trends in drug arrests and, 2) differences in arrests by offense, demographics (sex and age) and by region. **Methods:** Drug charges (N = 8,193, 31.3% female, age = 33.1 ± 9.9) reported to the DAP were examined by year, demographics, and location. **Results:** The most common substances of the 10,064 unique arrests reported were heroin (N = 2,203, 21.9%), crack/cocaine (N = 945, 16.8%), buprenorphine (N = 812, 8.1%), and oxycodone (N = 747, 7.4%). While the overall number of arrests reported to the DAP declined in 2017, the proportion of arrests involving opioids (heroin, buprenorphine, or fentanyl) and stimulants (cocaine/crack cocaine, or methamphetamine), increased ($p < .05$). Women had significantly increased involvement in arrests involving sedatives and miscellaneous pharmaceuticals (e.g. gabapentin) while men had an elevation in stimulant arrests. Heroin accounted for a lower percentage of arrests among individuals age ≥ 60 (6.6%) relative to young-adults (18-29, 22.3%, $p < .0001$). Older-adults had significantly more arrests than younger-adults for oxycodone, hydrocodone, and marijuana. **Conclusion:** Heroin had the most arrests from 2014-2017. Buprenorphine, fentanyl and crack/cocaine arrests increased appreciably suggesting that improved treatment is needed to prevent further nonmedical use and overdoses. The Diversion Alert Program provided a unique data source for research, a harm-reduction tool for health care providers, and an informational resource for law enforcement.

Introduction

Despite ongoing reductions in opioid prescribing [1,2], deaths in the United States from opioid overdoses continue to climb [3]. The contrast between a reduced supply of licit opioids and a further escalation of opioid deaths is especially evident in Maine. Opioid prescribing volume in the US declined by 11% from 2016 to 2017 while Maine had the largest decline of nearly 25% [4]. Maine experienced an 11.2% increase in overdose deaths from 2016 to 2017. The profile of decedents was predominately (71.5%) male, middle-aged, with four-fifths (78.9%) testing positive for multiple drugs [5]. Further, Maine had the second highest rate in the US of pregnant women with an opioid use disorder (34.1 / 1,000) [6]. It is unclear whether the epidemic is being driven by increased opioid demand or supply, given that rates of deaths of despair (suicide and unintentional overdose) involving opioids have increased 2.5 fold (17% to 42%) since 2000, suggesting increased demand [7]. Although opioids continue to receive the most attention, there have also been concerns about increased overdoses involving cocaine [3].

Maine has adopted several new public health policies and programs in an attempt to fetter and ultimately reverse this deadly trend. Recent laws have mandated use of the Prescription Drug Monitoring Program (PDMP) by prescribers and pharmacists, implemented dose and supply limits for opioid prescriptions and increased access to naloxone [1, 8, 9]. Furthermore, strategies such as the Diversion Alert Program (DAP) provided information to medical professions regarding persons arrested for offenses involving prescription or recreational drugs [10, 11]. The DAP was operational from 2013 until 2018 and provided a unique state-level resource which aimed to reduce prescription drug diversion. Law enforcement reported arrests involving prescription or illicit drugs to a database accessible to prescribers and pharmacists. The DAP has been reported to increase communication between healthcare providers and patients with suspected nonmedical drug use behaviors [12]. The DAP has also demonstrated utility as a public health tool to evaluate patterns in drug usage [5, 10, 11, 13, 14].

Many criminal justice systems make a distinction between possession and trafficking. The intentional or knowing possessing of what is known or believed to be a scheduled drug is possession. There are minimum thresholds like 200 mg of heroin, fentanyl, oxycodone, hydrocodone, or methamphetamine or 2 g of cocaine to classify as possession. Trafficking may refer to creating, manufacturing or being arrested with larger weights (e.g. 2 g or > 90 containers of heroin or fentanyl powder; 14 g methamphetamine or cocaine; 4 g cocaine base, 800 mg of oxycodone, 200 mg of hydromorphone) of a controlled substance [15]. Over three-quarters of persons reported to the DAP in 2014 for trafficking controlled prescription medications did not have a record for this substance in the state's Prescription Monitoring Program [10] indicating that these databases provide complementary, but non-redundant, information.

Buprenorphine availability and use in Maine [5] parallels the national pattern [1] with appreciable gains [5]. Almost half of opioid prescriptions to young-adults in their twenties was for buprenorphine [13]. However, of the top five most prescribed drugs based on Maine insurance claims, more money was spent on the buprenorphine and naloxone film (Suboxone, \$16.8 million) in 2017 than on the other four agents (hydrochlorothiazide, ProAir, Ventolin, and omeprazole) combined (\$12.7 million) [16]. Buprenorphine, when dosed flexibly, and methadone equally suppressed illicit opioid use but buprenorphine was inferior to methadone in treatment retention. Fixed buprenorphine doses of 16 mg/day or greater were no different in efficacy from methadone [17]. The first-line of the warnings and precautions section of the US package insert for the film notes "buprenorphine can be abused in a similar manner to other opioids". This is key information as there is an increasing evidence about nonmedical buprenorphine use including diversion and injection [18-20]. The US street value per mg of buprenorphine was over double that of methadone, oxycodone, and hydrocodone and four-fold that of morphine [21]. Importantly, nonmedical use of buprenorphine is safer than nonmedical use of full opioid agonists via a reduction in overdose risk. In the general population, methadone was associated with over six-times more fatal overdoses than buprenorphine.

Our objectives in this report were to analyze the 2014-2017 Maine DAP data for trends in arrests for both illicit (e.g. heroin) and prescription drugs (e.g. buprenorphine) including by year, region, arrestee demographic (sex and age), and offense (possession versus trafficking).

Materials and Methods

Subjects

Subjects included all individuals age 18 or older reported to the Maine DAP for drug crimes (N = 8,193, 31.27% female, mean age = 33.07, SD = 9.92, Min = 18, Max = 83). Information regarding sex, age, offense, drug(s), arrest date, town of residence, and reporting agency were submitted by city, county, state, and federal law enforcement personnel.

Procedures

Substances were categorized into drug classes: 1) opioids (e.g. heroin, methadone); 2) stimulants (e.g. cocaine, amphetamines); 3) sedatives (e.g. benzodiazepines, barbiturates, zolpidem); 4) hallucinogens / other (e.g. psychedelic mushrooms, marijuana, alpha-pyrrolidinopentiophenone (a-PVP), methylenedioxymethamphetamine (MDMA)); 5) miscellaneous pharmaceutical including substances not included in 1-4 that are typically manufactured by a pharmaceutical company (e.g. gabapentin); and 6) other (e.g. unspecified drugs, inhalants, drug paraphernalia). These classes have been used previously in single-year reports [5, 14]. Drugs were further classified in accordance to the US 1970 Controlled Substances Act as Schedule I-V, non-controlled prescription, or over the counter (e.g. pseudoephedrine). Arrestee age was categorized into six groups, 18-29 (41.07%), 30-39 (34.46%), 40-49 (13.85%), 50-59 (6.19%), ≥ 60 (1.43%), and age not reported (3.00%). A regional analysis was completed by examining the county of residence of the arrestee. The

Institutional Review Board approved this study and procedures were in accordance with the 2004 revision of the Helsinki Declaration.

Data-analysis

The DAP began in June, 2013 and ceased operation due to unstable funding in early 2018. Only full-years (2014 – 2017) were examined. The term arrests will be used interchangeably with all other types of drug charges reported including summons or indictments for this report. Arrest offenses were categorized into possession, furnishing, possession with intent to distribute, trafficking, manufacturing, operating under the influence (OUI), and other. For examination of arrests involving multiple drugs (Max = 12), each unique drug reported per offense was the unit of analysis [11, 14]. Epi Info, version 7.2.1.0 was used to analyze the data. Figures were created using GraphPad Prism, version 7.04. Fisher's Exact Test or chi-square test with Yates' Correction for non-parametric analyses were performed using GraphPad chi-square calculator. Unpaired t-tests were performed using GraphPad t-test calculator. An alpha of < .05 was considered significant although statistics that met more conservative thresholds were noted. Heat maps were created with CARTO. County and state populations were derived from the US Census Bureau population estimates for April 1 of each year analyzed. The Arrest Ratio (AR) was calculated as the percent arrests (number arrests countywide / total arrests statewide) divided by the percent population (county population / Maine total population). An AR >1 indicate more arrests in a county than expected based on population. Variability was expressed as the standard deviation (SD).

Results

Drug arrests were reported to the DAP by local (52.57%), county (7.99%), state (33.30%), and federal (6.14%) agencies. After accounting for arrests involving multiple drugs, there were 10,064 unique charges. Of the 1,353 arrestees with multiple charges, over two-thirds were male (68.37%) or under forty (73.02%).

Figure 1A shows the percentage of charges for each drug class by year and tested for changes relative to 2014. Opioids accounted for over two-fifths of arrests which remained stable with the exception of an increase in 2016 ($p \leq .0003$). Stimulants were the second most common class with elevations in 2016 ($p < .01$) and 2017 ($p < 0.01$). The miscellaneous pharmaceuticals class accounted for less than one-tenth of arrests and was transiently increased in 2015 ($p \leq .0008$). Hallucinogens and the other classes were each significantly ($p \leq .01$) lower each year after 2014. Figure 1B further examines some of the most common drugs by year. Heroin, buprenorphine, alprazolam, methamphetamine, and fentanyl were significantly increased in 2017 relative to 2014 while unspecified agents and oxycodone decreased. Arrests for cocaine and crack cocaine were more frequent than heroin in 2017 (Supplemental Tables 1 and 2).

Figure 2 depicts arrests by charge and reveals that, overall, possession accounted for three-fifths (60.0%) of arrests, trafficking one-quarter (24.5%), followed by distribution (3.9%) and possession with intent to distribute (3.5%). The benzodiazepines were most common ($\geq 85.5\%$) for possession. Crack had the highest percentage trafficking (43.7%). One-fifth of fentanyl arrests were for distribution (20.3%) which was twice as common as the next highest drug (cocaine = 9.5%). Manufacturing was fifteen-fold higher for methamphetamine (13.3%) relative to the next most common agent (marijuana = 0.9%). Marijuana led for OUI (6.4%) and other (15.3%) arrests (Supplemental Table 3).

The sexes showed broad similarities in the classes and DEA Schedule. However, small, but significant, differences were noted with males being arrested more commonly for stimulants and hallucinogens and females for sedatives and miscellaneous pharmaceutical agents (Figure 3A). Figure 3B

depicts the Schedule of drugs (note that Schedule V (N = 12) was not shown due to limited data, see also Supplemental Tables 4-5). Males were more likely to be arrested for Schedule I agents and females for Schedule IV and non-controlled prescriptions. Males (33.29 ± 10.25 , Min = 18, Max = 83) and females (32.59 ± 9.16 , Min = 18, Max = 67) were equivalent in age.

Figure 4 reports on age differences by drug. Heroin accounted for three-fold more arrests for young-adults (age 18 to 29) than for older-adults (age ≥ 60). Conversely, older-adults were significantly more likely than young-adults to be arrested for oxycodone, hydrocodone, or marijuana (Supplemental Tables 6-8).

Arrest data was examined by county. The most arrests occurred in Cumberland (27.15%), Penobscot (12.22%), and Androscoggin (11.32%) which rank first, third, and fifth, respectively, among the sixteen Maine counties for population. Additional information about changes in arrests over time may be found in Supplemental Table 9. A population corrected AR was obtained separately for opioids and stimulants (Supplemental Figure 1, Supplemental Tables 10 and 11). The western and northern counties of Oxford, Franklin, and Piscataquis ranked in the lower third ($AR \leq .70$). Only Androscoggin ranked in the upper-third ($AR \geq 1.30$) for both opioid and stimulant arrests. The correlation between the AR for opioids and stimulants was not significant ($r(14) = 0.42$, $p = .11$).

Figure 1. Percent of drug classes (A) and selected drugs (B) by year reported to the Maine Diversion Alert Program. * $p \leq .05$ versus 2014.

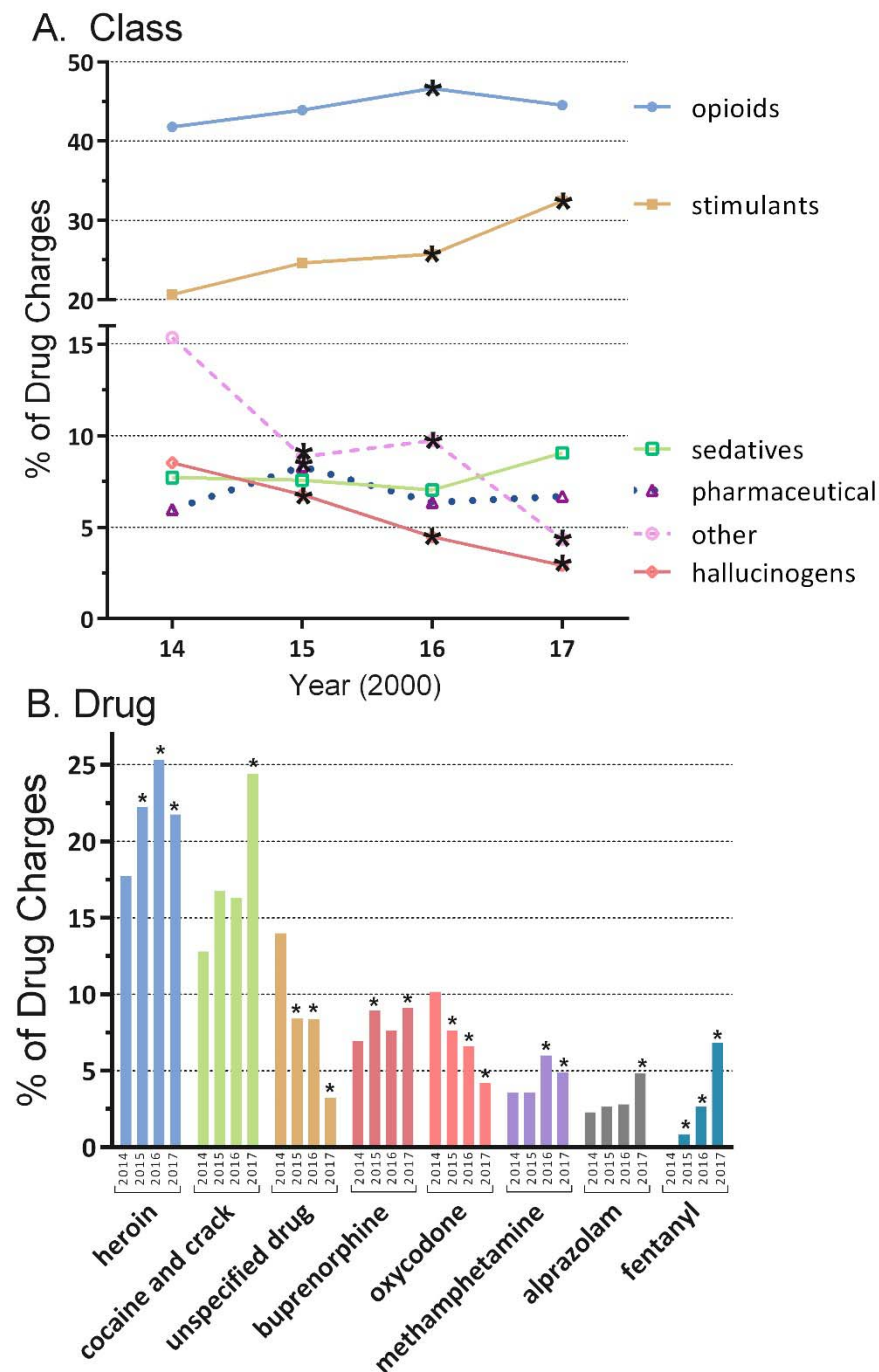


Figure 2. Arrest charge by drug, ranked by percent Possession, reported to the Maine Diversion Alert Program from 2014 to 2017. Operating Under the Influence: OUI. Number of arrests is in parentheses.

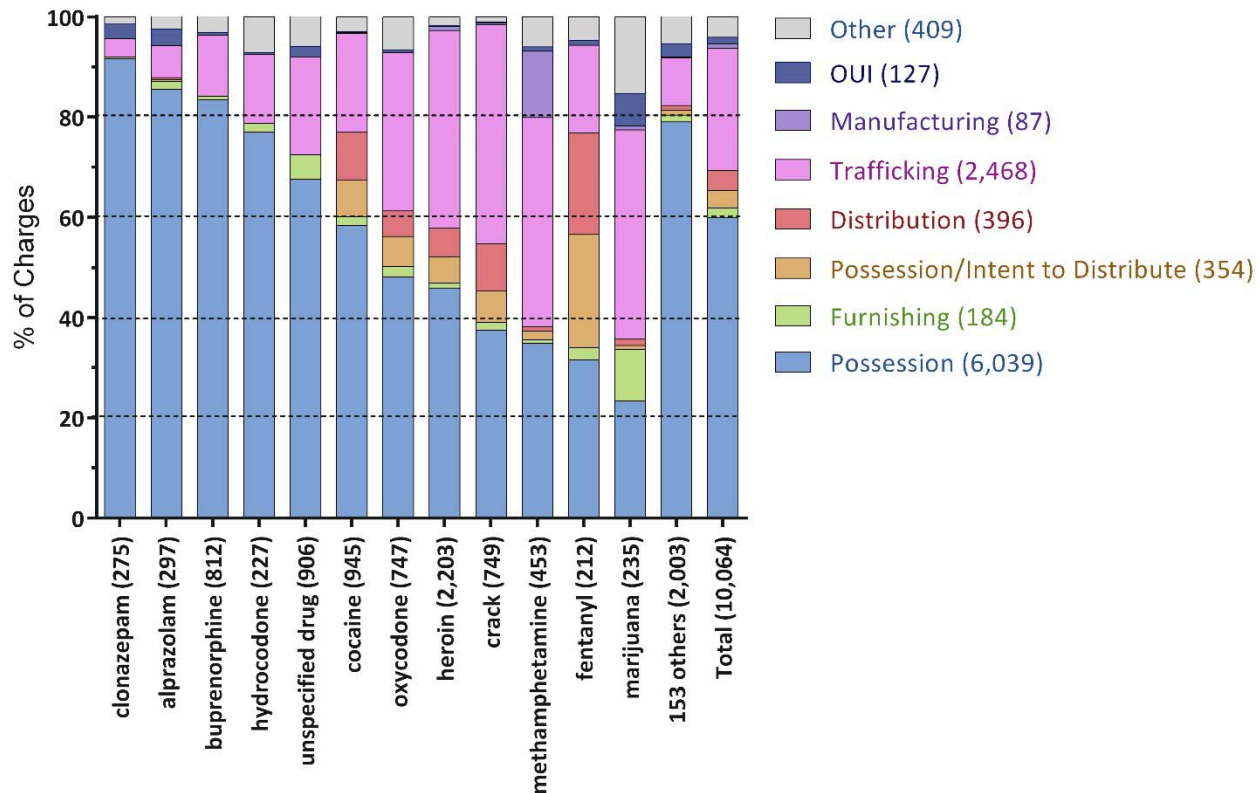


Figure 3. Drug class (A) and schedule (B) by sex reported to the Maine Diversion Alert Program from 2014-2017. Number of arrests are in parentheses. Rx: non-controlled prescription drug.

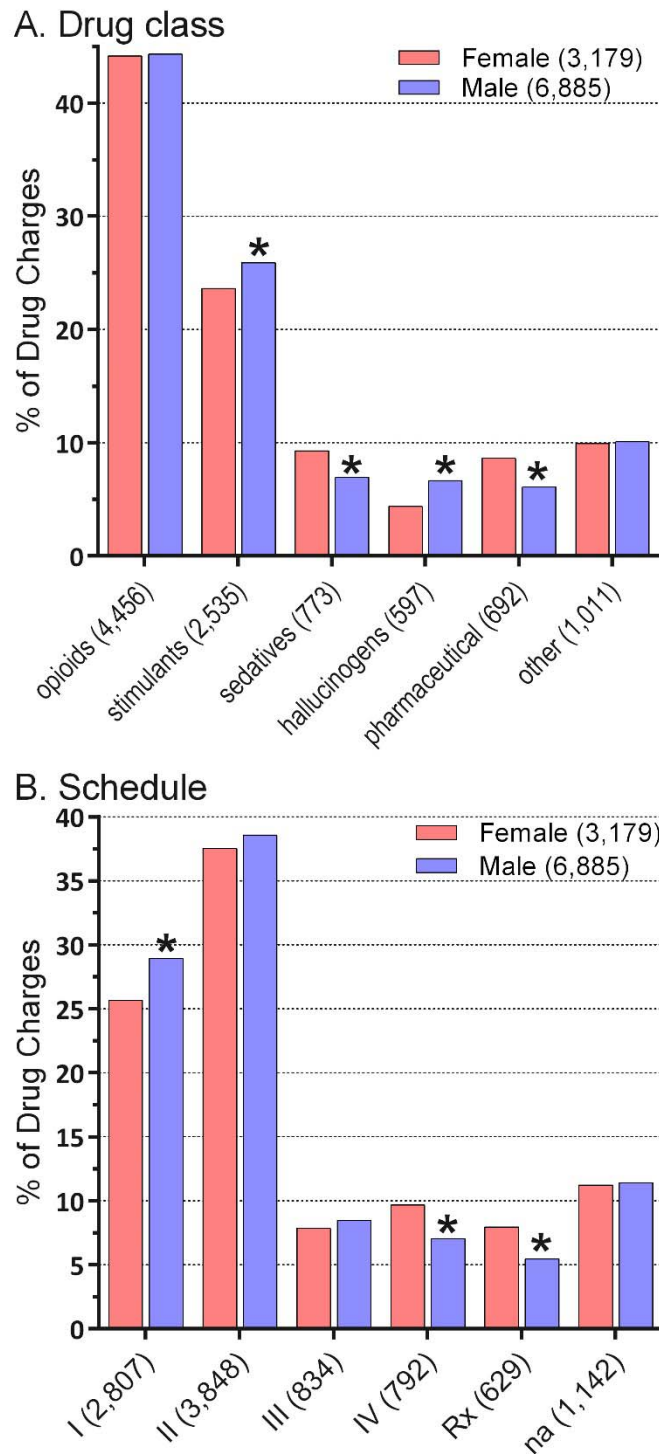
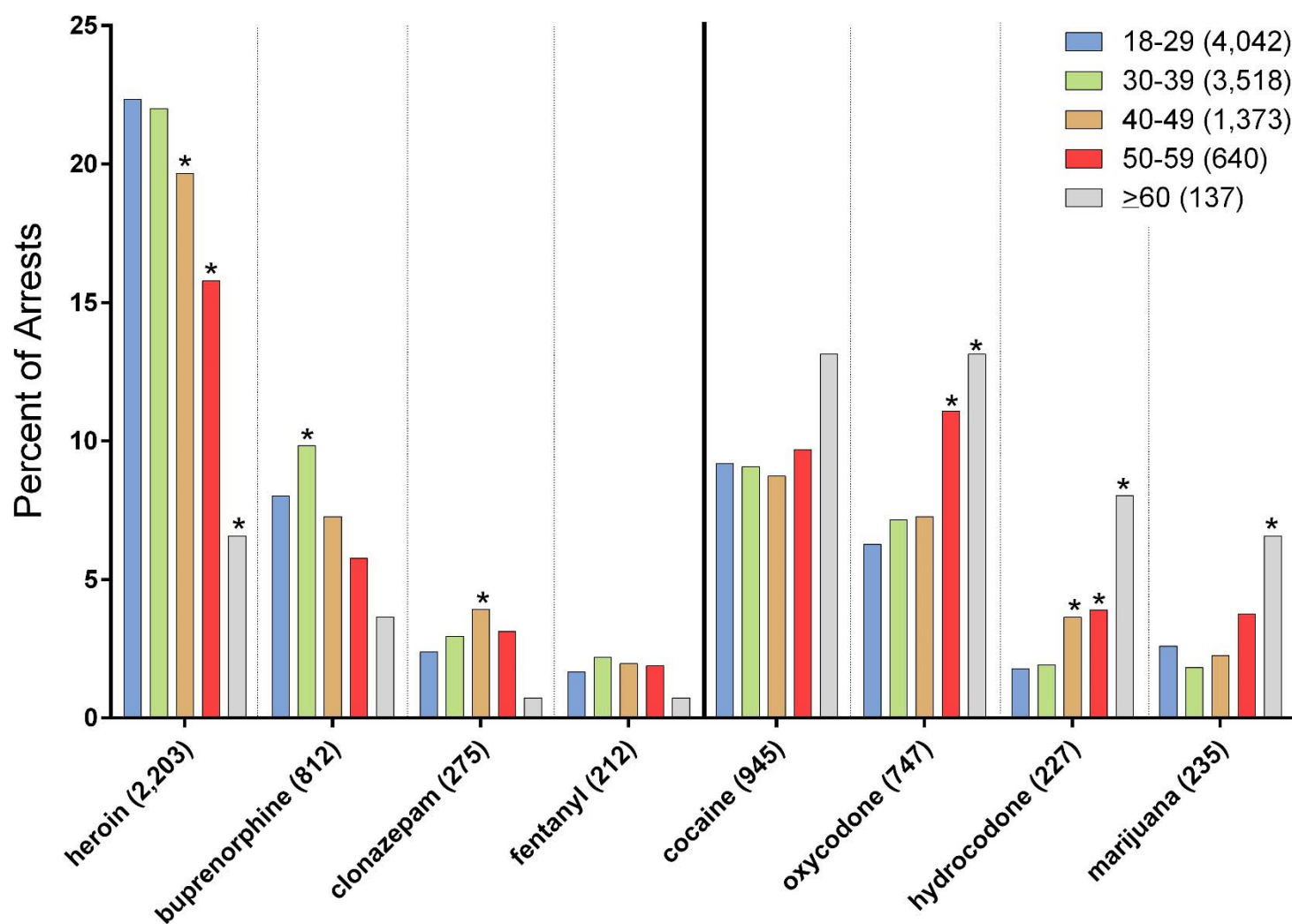
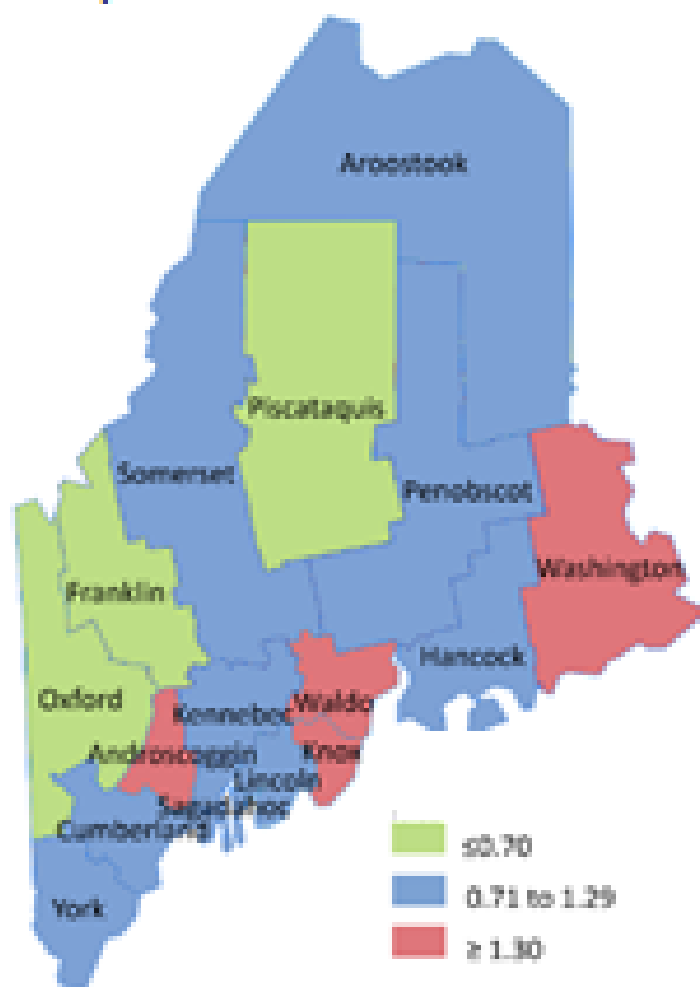


Figure 4. Age differences in drugs reported to the Maine Diversion Alert Program from 2014 to 2017. * $p < .05$ versus 18 – 29.



Supplemental Figure 1. Heat map of the arrest ratio (arrests / population) for opioids (A) and stimulants (B) reported to the Maine Diversion Alert Program from 2014 to 2017.

A. Opioids



B. Stimulants



Supplemental Table 1. Frequency of arrests reported to the Maine Diversion Alert Program

from 2014-2017 by drug class. ^aFisher's Exact Test *p* values relative to 2014.

Class		Year				
		2014-2017	2014	2015	2016	2017
opioids	n	4,456	1,079	1,290	1,368	719
	%	44.28%	41.81%	43.91%	46.67%	44.55%
	<i>p</i> ^a	-	-	0.12	0.0003*	0.08
stimulants	n	2,535	533	723	755	524
	%	25.19%	20.65%	24.61%	25.76%	32.47%
	<i>p</i> ^a	-	-	0.14	<0.001*	<0.001*
sedatives	n	773	199	222	206	146
	%	7.68%	7.71%	7.56%	7.03%	9.05%
	<i>p</i> ^a	-	-	0.84	0.35	0.13
hallucinogens / other	n	597	220	199	131	47
	%	5.93%	8.52%	6.77%	4.47%	2.91%
	<i>p</i> ^a	-	-	0.01*	<0.001*	<0.001*
miscellaneous pharmaceutical	n	692	154	244	186	108
	%	6.88%	5.97%	8.30%	6.35%	6.69%
	<i>p</i> ^a	-	-	0.0008*	0.58	0.36
other	n	1,011	396	260	285	70
	%	10.05%	15.34%	8.85%	9.72%	4.34%
	<i>p</i> ^a	-	-	<0.001*	<0.001*	<0.001*
Total	n	10,064	2,581	2,938	2,931	1,614
	%	100.00%	100.00%	100.00%	100.00%	100.00%

Supplemental Table 2. Ranking of the most commonly reported drugs to the Maine Diversion Alert Program from 2014-2017. α -PVP. ^aFisher's Exact Test *p* relative to 2014.

Drug	Year											
	2014 (2,581)			2015 (2,938)			2016 (2,931)			2017 (1,614)		
	n	%	<i>p</i>	n	%	<i>p</i> ^a	n	%	<i>p</i> ^a	n	%	<i>p</i> ^a
1. heroin (2,203)	457	17.71%	-	653	22.23%	<0.01*	742	25.32%	<0.01*	351	21.75%	0.002*
2. cocaine (945)	178	6.90%	-	314	10.69%	<0.01*	250	8.53%	0.03*	203	12.58%	<0.01*
3. unspecified drug (906)	361	13.99%	-	247	8.41%	<0.001*	246	8.39%	<0.01*	52	3.22%	<0.001*
4. buprenorphine (812)	179	6.94%	-	263	8.95%	0.006*	223	7.61%	0.35	147	9.11%	0.052
5. oxycodone (747)	262	10.15%	-	224	7.62%	0.001*	193	6.58%	<0.001*	68	4.21%	<0.001*
6. crack (749)	152	5.89%	-	178	6.06%	0.82	228	7.78%	0.007*	191	11.83%	<0.001*
7. methamphetamine (453)	93	3.60%	-	105	3.57%	1	176	6.00%	<0.001*	79	4.89%	0.05*
8. alprazolam (297)	59	2.29%	-	78	2.65%	0.39	82	2.80%	0.23	78	4.83%	<0.001*
9. clonazepam (275)	90	3.49%	-	77	2.62%	0.07	73	2.49%	0.03*	35	2.17%	0.02*
10. amphetamine (205)	54	2.09%	-	68	2.31%	0.58	54	1.84%	0.56	29	1.80%	0.57
11. hydrocodone (227)	98	3.80%	-	63	2.14%	0.0003*	53	1.81%	<0.001*	13	0.81%	<0.001*
12. marijuana (235)	80	3.10%	-	83	2.83%	0.58	44	1.50%	<0.001*	28	1.73%	0.007*
13. fentanyl (212)	0	0.00%	-	24	0.82%	<0.001*	78	2.66%	<0.001*	110	6.82%	<0.001*
14. α -PVP/bath salts (160)	85	3.29%	-	52	1.77%	0.0003*	21	0.72%	<0.001*	2	0.12%	<0.001*
15. gabapentin (148)	18	0.70%	-	63	2.14%	<0.001*	41	1.40%	0.01*	26	1.61%	0.007*
16. methylphenidate (111)	35	1.36%	-	36	1.23%	0.72	20	0.68%	0.01*	20	1.24%	0.78
17. methadone (82)	35	1.36%	-	22	0.75%	0.03*	15	0.51%	0.001*	10	0.62%	0.03*

Supplemental Table 3. Charges reported to the Maine Diversion Alert Program from 2014-2017 by drug and offense category. alpha-pyrrolidinopentiophenone: α -PVP; Operating Under the Influence: OUI. ^achi-square with Yates' Correction determined *p* values by comparing each offense per drug relative to all other offenses and drugs.

Drug (N)		Offense						
		Possession	Trafficking	Distribution	Possession/Intent to Distribute	Manufacturing	OUI	Other
1. heroin (2,203)	N	1,012	870	126	115	17	6	57
	%	45.94	39.49	5.72	5.22	0.77	0.27	2.59
	p	<0.001*	<0.001*	<0.001*	<0.001*	0.69	<0.001*	<0.001*
2. cocaine (945)	N	552	186	90	70	2	1	44
	%	58.41	19.68	9.52	7.41	0.21	0.11	4.66
	p	0.31	0.0003*	<0.001*	<0.001*	0.04*	0.001*	0.1
3. unspecified drug (906)	N	612	176	0	0	0	19	99
	%	67.55	19.43	0	0	0	2.1	10.93
	p	<0.001*	0.0002*	<0.001*	<0.001*	0.006*	0.03*	<0.001*
4. buprenorphine (812)	N	678	98	0	1	0	5	30
	%	83.5	12.07	0	0.12	0	0.62	3.69
	p	<0.001*	<0.001*	<0.001*	<0.001*	0.001*	0.12	0.007*
5. crack (749)	N	281	327	71	46	3	1	20
	%	37.52	43.66	9.48	6.14	0.4	0.13	2.67
	p	<0.001*	<0.001*	<0.001*	<0.001*	0.22	0.007*	<0.001*
6. oxycodone (747)	N	360	236	38	45	0	4	64
	%	48.19	31.59	5.09	6.02	0	0.54	8.57
	p	<0.001*	<0.001*	0.11	0.0002*	0.01*	0.09	0.002*
7. methamphetamine (453)	N	158	189	4	8	60	4	30
	%	34.88	41.72	0.88	1.77	13.25	0.88	6.62
	p	<0.001*	<0.001*	0.001*	>0.05	<0.001*	0.6	0.57
8. alprazolam (297)	N	254	19	1	1	0	10	12
	%	85.52	6.4	0.34	0.34	0	3.37	4.04
	p	<0.001*	<0.001*	0.002*	0.004*	0.19	0.002*	0.21
9. clonazepam (275)	N	252	10	0	0	0	8	5
	%	91.64	3.64	0	0	0	2.91	1.82
	p	<0.001*	<0.001*	0.001*	0.002*	0.22	0.03*	0.005*
10. marijuana (235)	N	55	98	3	2	2	15	60
	%	23.4	41.7	1.28	0.85	0.85	6.38	25.53
	p	<0.001*	<0.001*	>0.05	0.04*	0.98	<0.001*	<0.001*

11. hydrocodone (227)	N	175	31	0	0	0	1	20
	%	77.09	13.66	0	0	0	0.44	8.81
	p	<0.001*	0.0002*	0.004*	0.006*	0.29	0.41	0.08
12. fentanyl (212)	N	67	37	43	48	0	2	15
	%	31.6	17.45	20.28	22.64	0	0.94	7.08
	p	<0.001*	0.02*	<0.001*	<0.001*	0.32	0.91	0.55
13. amphetamine (205)	N	176	13	0	0	0	4	12
	%	85.85	6.34	0	0	0	1.95	5.85
	p	<0.001*	<0.001*	0.006*	0.01*	0.33	0.56	0.98
14. α -PVP/bath salts (160)	N	70	51	14	9	1	2	13
	%	43.75	31.86	8.75	5.63	0.63	1.25	8.13
	p	<0.001*	0.04*	0.003*	0.21	0.74	0.99	0.3
15. gabapentin (148)	N	137	3	0	0	0	1	7
	%	92.57	2.03	0	0	0	0.68	4.73
	p	<0.001*	<0.001*	0.02*	0.03*	0.49	0.79	0.67
16. methylphenidate (111)	N	85	15	0	0	0	0	11
	%	76.58	13.51	0	0	0	0	9.91
	p	0.0005*	0.009*	0.06	0.08	0.64	0.44	0.11
17. methadone (82)	N	67	6	0	0	0	4	5
	%	81.71	7.32	0	0	0	4.88	6.1
	p	<0.001*	0.0005*	0.12	0.15	0.8	0.01*	0.94

Supplemental Table 4. Arrests by drug class and sex reported to the Maine Diversion Alert

Program from 2014-2017. ^aFisher's Exact Test *p* values evaluated relative to all other classes.

*statistically significant

Class	Female (3,179)		Male (6,885)		<i>p</i> ^a
opioids (4,456)	1,404	44.16%	3,052	44.33%	0.90
sedatives (773)	295	9.28%	478	6.94%	0.015
stimulants (2,535)	751	23.62%	1784	25.91%	0.001*
hallucinogens / other (597)	139	4.37%	458	6.65%	0.001*
miscellaneous pharmaceutical (692)	274	8.62%	418	6.07%	0.001*
other (1,011)	316	9.94%	695	10.09%	0.84

Supplemental Table 5. Arrests by federal schedule and sex reported to the Maine Diversion

Alert Program from 2014-2017. N is in parentheses. Rx: prescription but non-controlled. N/A:

not applicable or unknown. ^aFisher's Exact Test *p* values compared sex relative to all other Schedules.

Schedule	Female (3,179)		Male (6,885)		<i>p</i> ^a
I (2,807)	815	25.64%	1,992	28.93%	<.001*
II (3,848)	1,193	37.53%	2,655	38.56%	0.33
III (834)	250	7.86%	584	8.48%	0.31
IV (792)	307	9.66%	485	7.04%	<.001*
V (12)	4	0.13%	8	0.12%	0.90
Rx (629)	253	7.96%	376	5.46%	<.001*
N/A (1,142)	357	11.23%	785	11.40%	.83

Supplemental Table 6. Drug charges reported to the Maine Diversion Alert Program from 2014-2017 by drug class, age, and sex. ^aFisher's Exact Test *p* values comparing each age group by sex against others.

Class	Age	Male		Female		p ^a
		N	%	N	%	
opioids (N = 4,456)	18-29	1,104	68.49	592	34.91	0.0002*
	30-39	1,116	69.97	502	31.03	0.62
	40-49	406	69.58	186	31.42	1
	50-59	193	73.11	71	26.89	0.1
	60+	39	76.47	12	23.53	0.29
	Unknown	194	82.55	41	17.45	<0.001*
	Total	3,052	68.49	1,404	31.51	0.9
stimulants (N = 2,535)	18-29	724	70.16	308	29.84	0.86
	30-39	570	66.67	285	33.33	0.004*
	40-49	243	69.43	107	30.57	0.71
	50-59	128	79.01	34	20.99	0.01*
	60+	27	84.38	5	15.63	0.12
	Unknown	92	88.46	12	11.54	<0.001*
	Total	1,784	70.37	751	29.63	0.03*
sedatives (N = 773)	18-29	190	61.69	118	38.31	1
	30-39	173	61.13	110	38.87	0.76
	40-49	74	62.18	45	37.82	1
	50-59	32	61.54	20	38.46	1
	60+	9	81.82	2	18.18	0.22
	Unknown	0	0	0	0	1
	Total	478	61.84	295	38.16	<0.001*
miscellaneous pharmaceuticals (N = 692)	18-29	173	58.64	122	41.36	0.43
	30-39	136	59.13	94	40.87	0.68
	40-49	57	54.29	48	45.71	0.19
	50-59	46	85.19	8	14.81	<0.001*
	60+	6	75	2	25	0.49
	Unknown	0	0	0	0	1
	Total	418	60.4	274	39.6	<0.001*
hallucinogens/other (N = 597)	18-29	199	73.16	73	26.84	0.07
	30-39	133	78.7	36	21.3	0.52
	40-49	51	69.92	23	31.08	0.11
	50-59	47	90.38	5	9.62	0.02*
	60+	16	88.89	2	11.11	0.27

	Unknown	12	100	0	0	0.08
	Total	458	76.72	139	23.28	<0.001*
other (N = 1,011)	18-29	316	71.98	123	28.02	0.06
	30-39	232	63.91	131	36.09	0.05*
	40-49	93	69.92	40	30.08	0.84
	50-59	37	66.07	19	33.93	0.66
	60+	15	88.24	2	11.76	0.11
	Unknown	2	66.67	1	33.33	1
	Total	695	68.74	316	31.26	0.84

Supplemental Table 7. Percentage of charges by drug and age (excludes N = 246 arrests and N = 354

substances where age was not listed) reported to the Maine Diversion Alert Program from 2014-2017. Numbers of arrests for each drug or age category are listed in parentheses. ^aFisher's Exact Test *p* values relative to age 18-29.

Drug (N)		Age					No age provided (354)
		18-29 (4,042)	30-39 (3,518)	40-49 (1373)	50-59 (640)	60+ (137)	
1. heroin (2,203)	N	903	774	270	101	9	146
	%	40.99%	35.13%	12.26%	4.58%	0.41%	6.63%
	<i>p</i> ^a		0.7392	0.0406*	0.0001*	<0.0001*	<0.0001*
2. cocaine (945)	N	372	319	120	62	18	54
	%	39.37%	33.76%	12.70%	6.56%	1.90%	5.71%
	<i>p</i> ^a		0.8416	0.6252	0.7137	0.1333	0.0005*
3. unspecified drug (906)	N	394	331	116	47	15	3
	%	43.49%	36.53%	12.80%	5.19%	1.66%	0.33%
	<i>p</i> ^a		0.6385	0.1645	0.058	0.6599	0.0001*
4. buprenorphine (812)	N	324	346	100	37	5	0
	%	39.90%	42.61%	12.32%	4.56%	0.62%	0.00%
	<i>p</i> ^a		0.0058*	0.4157	0.0552	0.0736	<0.0001*
5. crack (749)	N	308	238	110	44	7	42
	%	41.12%	31.78%	14.69%	5.87%	0.93%	5.61%
	<i>p</i> ^a		0.1543	0.6399	0.5722	0.3256	0.0074*
6. oxycodone (747)	N	254	252	100	71	18	52
	%	34.00%	33.73%	13.39%	9.50%	2.41%	6.96%
	<i>p</i> ^a		0.1282	0.2062	0.0001*	0.0039*	<0.0001*
7. methamphetamine (453)	N	183	169	61	29	4	7
	%	40.40%	37.31%	13.47%	6.40%	0.88%	1.55%
	<i>p</i> ^a		0.5845	0.9401	1	0.5263	0.02*
8. alprazolam (297)	N	130	110	34	19	4	0
	%	43.77%	37.04%	11.45%	6.40%	1.35%	0.00%
	<i>p</i> ^a		0.8438	0.1248	0.8094	1	<0.0001*
9. clonazepam (275)	N	96	104	54	20	1	0
	%	34.91%	37.82%	19.64%	7.27%	0.36%	0.00%
	<i>p</i> ^a		0.1312	0.0031	0.2722	0.3773	0.0005*
10. marijuana (235)	N	105	64	31	24	9	2
	%	44.68%	27.23%	13.19%	10.21%	3.83%	0.85%
	<i>p</i> ^a		0.0236*	0.5495	0.1172	0.0118*	0.011*
11. hydrocodone (227)	N	72	68	50	25	11	1
	%	31.72%	29.96%	22.03%	11.01%	4.85%	0.44%
	<i>p</i> ^a		0.6692	<0.0001*	0.0014*	<0.0001*	0.0282*
12. fentanyl (212)	N	67	77	27	12	1	28
	%	31.60%	36.32%	12.74%	5.66%	0.47%	13.21%
	<i>p</i> ^a		0.1087	0.473	0.6232	0.7268	<0.0001*
Total (10,064)	N	4,042	3,518	1,373	640	137	354
	%	40.16%	34.96%	13.64%	6.36%	1.36%	3.52%

Supplemental Table 8. Prevalence of drug charges by age and year reported to the Maine Diversion Alert

Program from 2014-2017. ^aFisher's Exact Test p values relative to 2014.

Age	Years											
	2014			2015			2016			2017		
	N	%	p	N	%	p ^a	N	%	p ^a	N	%	p ^a
18-29 (3,365)	974	45.22%	-	997	41.58%	0.01*	920	38.83%	<0.01*	474	37.26%	<0.01*
30-39 (2,823)	715	33.19%	-	777	32.40%	0.59	836	35.29%	0.14	495	38.92%	0.0008*
40-49 (1,135)	293	13.60%	-	354	14.76%	0.27	320	13.51%	0.93	168	13.21%	0.76
50-59 (507)	121	5.62%	-	153	6.38%	0.29	148	6.25%	0.38	85	6.68%	0.21
60+ (117)	28	1.30%	-	32	1.33%	1	34	1.44%	0.7	23	1.81%	0.25
Not specified (246)	23	1.07%	-	85	3.54%	<0.01*	111	4.69%	<0.01*	27	2.12%	0.02*
Total (8,193)	2,154	100.00%	-	2,398	100.00%	-	2,369	100.00%	-	1,272	100.00%	-

Supplemental Table 9. Arrests by county, ranked by the percent change in Arrest Ratio (AR), as reported to the Maine Diversion Alert Program from 2014-2017. AR is the percent arrests divided by percent population. ^CValues ≤ 5 obscured to protect arrestee confidentiality.

County		2014	2015	2016	2017	2014-2017 total / average / density	AR % Change from 2014 to 2017
Piscataquis	Arrests	^C	8	14	^C	27	
	Population estimates	17021	16926	16843	16773	16890.75	
	% Arrests / % Population	7.45%	26.26%	46.96%	19.94%	26.59%	167.50%
Penobscot	Arrests	216	291	284	199	990	
	Population estimates	153500	152478	151806	151957	152435.25	
	% Arrests / % Population	89.25%	106.03%	105.68%	145.97%	108.01%	63.55%
Washington	Arrests	44	78	76	40	238	
	Population estimates	31834	31604	31450	31593	31620.25	
	% Arrests / % Population	87.67%	137.11%	136.51%	141.13%	125.18%	60.98%
Franklin	Arrests	17	22	34	14	87	
	Population estimates	30203	30039	30001	29988	30057.75	
	% Arrests / % Population	35.70%	40.69%	64.02%	52.04%	48.14%	45.76%
Kennebec	Arrests	122	182	228	98	630	
	Population estimates	121167	120209	120569	121821	120941.5	
	% Arrests / % Population	63.86%	84.11%	106.83%	89.67%	86.63%	40.41%
Sagadahoc	Arrests	33	55	52	23	163	
	Population estimates	35086	35173	35273	35392	35231	
	% Arrests / % Population	59.66%	86.87%	83.28%	72.44%	76.95%	21.42%
Somerset	Arrests	63	55	46	37	201	
	Population estimates	51258	51056	50915	50626	50963.75	
	% Arrests / % Population	77.96%	59.85%	51.04%	81.47%	65.59%	4.50%
York	Arrests	195	226	187	113	721	
	Population estimates	200686	201158	202343	204191	202094.5	
	% Arrests / % Population	61.63%	62.42%	52.21%	61.69%	59.33%	0.09%
Oxford	Arrests	59	53	70	32	214	
	Population estimates	57291	57156	57217	57439	57275.75	
	% Arrests / % Population	65.32%	51.52%	69.11%	62.10%	62.14%	-4.93%
Cumberland	Arrests	599	652	627	322	2200	
	Population estimates	288258	290464	292041	292500	290815.75	
	% Arrests / % Population	131.80%	124.71%	121.28%	122.71%	125.82%	-6.90%
Hancock	Arrests	87	94	75	44	300	
	Population estimates	54550	54268	54419	54497	54433.5	
	% Arrests / % Population	101.16%	96.23%	77.85%	90.00%	91.66%	-11.03%
Androscoggin	Arrests	255	238	242	182	917	
	Population estimates	107408	107245	107319	170651	123155.75	
	% Arrests / % Population	150.59%	123.29%	127.38%	118.88%	123.83%	-21.06%
Aroostook	Arrests	161	133	150	67	511	
	Population estimates	69490	68752	67959	67653	68463.5	
	% Arrests / % Population	146.96%	107.47%	124.69%	110.39%	124.13%	-24.88%
Knox	Arrests	95	125	98	40	358	
	Population estimates	39785	39779	39744	39790	39774.5	
	% Arrests / % Population	151.46%	174.58%	139.29%	112.05%	149.69%	-26.01%
Waldo	Arrests	75	94	91	27	287	
	Population estimates	39000	39129	39364	39832	39331.25	
	% Arrests / % Population	121.98%	133.46%	130.59%	75.56%	121.36%	-38.06%
Lincoln	Arrests	75	87	83	14	259	
	Population estimates	34182	34017	34216	34204	34154.75	
	% Arrests / % Population	139.17%	142.09%	137.03%	45.62%	126.12%	-67.22%
Total	Arrests	2098	2393	2357	1255	8103	
	Population estimates	1330719	1329453	1331479	1398907	1347639.5	
	% Arrests / % Population	100.00%	100.00%	100.00%	100.00%	100.00%	

Supplemental Table 10. Opioid arrests by county reported to the Maine Diversion Alert Program from 2014-2017.

^cValues ≤ 5 are obscured to protect arrestee confidentiality.

Opioids by year											
County	2014		2015		2016		2017		Total		
Androscoggin	141	13.21%	137	10.64%	158	11.60%	92	12.96%	528	11.93%	1.31
Aroostook	56	5.25%	36	2.80%	53	3.89%	20	2.82%	165	3.73%	0.73
Cumberland	242	22.68%	292	22.67%	294	21.59%	150	21.13%	978	22.09%	1.02
Franklin	3	0.28%	10	0.78%	14	1.03%	11	1.55%	38	0.86%	0.38
Hancock	65	6.09%	54	4.19%	43	3.16%	32	4.51%	194	4.38%	1.08
Kennebec	85	7.97%	123	9.55%	173	12.70%	72	10.14%	453	10.23%	1.14
Knox	50	4.69%	69	5.36%	71	5.21%	23	3.24%	213	4.81%	1.63
Lincoln	38	3.56%	38	2.95%	42	3.08%	4	0.56%	122	2.76%	1.09
Oxford	34	3.19%	28	2.17%	44	3.23%	20	2.82%	126	2.85%	0.67
Penobscot	127	11.90%	163	12.66%	165	12.11%	109	15.35%	564	12.74%	1.13
Piscataquis	^c	0.09%	6	0.47%	9	0.66%	^c	0.14%	17	0.38%	0.31
Sagadahoc	7	0.66%	30	2.33%	29	2.13%	17	2.39%	83	1.87%	0.72
Somerset	43	4.03%	44	3.42%	34	2.50%	21	2.96%	142	3.21%	0.85
Waldo	49	4.59%	56	4.35%	50	3.67%	14	1.97%	169	3.82%	1.31
Washington	25	2.34%	36	2.80%	54	3.96%	21	2.96%	136	3.07%	1.31
York	101	9.47%	166	12.89%	129	9.47%	103	14.51%	499	11.27%	0.75
Total	1,067	100.00%	1,288	100.00%	1,362	100.00%	710	100.00%	4,427	100.00%	-

Supplemental Table 11. Stimulant arrests by county reported to the Maine Diversion Alert Program from 2014-2017. ^CValues ≤ 5 obscured to protect arrestee confidentiality.

Stimulants by year											
County	2014		2015		2016		2017		Total		
	N	%	N	%	N	%	N	%	N	%	density
Androscoggin	108	20.34%	92	12.74%	111	14.76%	94	18.15%	405	16.05%	1.76
Aroostook	55	10.36%	55	7.62%	81	10.77%	27	5.21%	218	8.64%	1.70
Cumberland	145	27.31%	213	29.50%	216	28.72%	133	25.68%	707	28.02%	1.30
Franklin	^C	0.94%	^C	0.69%	7	0.93%	^C	0.97%	22	0.87%	0.39
Hancock	12	2.26%	27	3.74%	17	2.26%	10	1.93%	66	2.62%	0.65
Kennebec	31	5.84%	57	7.89%	68	9.04%	37	7.14%	193	7.65%	0.85
Knox	22	4.14%	19	2.63%	16	2.13%	10	1.93%	67	2.66%	0.90
Lincoln	7	1.32%	13	1.80%	11	1.46%	5	0.97%	36	1.43%	0.56
Oxford	20	3.77%	16	2.22%	8	1.06%	18	3.47%	62	2.46%	0.58
Penobscot	45	8.47%	127	17.59%	108	14.36%	96	18.53%	376	14.90%	1.32
Piscataquis	^C	0.19%	^C	0.42%	^C	0.00%	^C	0.19%	^C	0.20%	0.16
Sagadahoc	10	1.88%	8	1.11%	^C	0.13%	9	1.74%	28	1.11%	0.42
Somerset	13	2.45%	23	3.19%	12	1.60%	16	3.09%	64	2.54%	0.67
Waldo	6	1.13%	8	1.11%	14	1.86%	^C	0.77%	32	1.27%	0.43
Washington	7	1.32%	8	1.11%	28	3.72%	9	1.74%	52	2.06%	0.88
York	44	8.29%	48	6.65%	54	7.18%	44	8.49%	190	7.53%	0.50
Total	531	100.00%	722	100.00%	752	100.00%	518	100.00%	2523	100.00%	-

Discussion

This study spanned four years of data involving over eight-thousand drug-related arrests and ten-thousand drug charges. This report is the largest and most thorough analysis of the Maine DAP to date [5, 11, 13, 14] and enables a comprehensive assessment of trends and demographic subgroup examination from a data source unlike any other in the US. Well-meaning regulatory and administrative barriers functioned to effectively ban US prisoners from much research [23] resulting in this IRB approved dataset being rare and valuable. The analysis of drug arrests and patterns of drug charges in this report may be used to guide public health policy and optimize resource utilization. The most unique aspect of this report is detailed reporting of the offenses involved (Figures 1-2) and examination by demographic characteristics (Figures 3-4).

Nationally and in Maine, the opioid epidemic can be visualized as three distinct waves. The first opioid wave of drug crimes and overdose deaths involving prescription drugs appears to be ebbing. For example, drug charges for prescription oxycodone and hydrocodone reported to the Maine DAP were significantly lower in 2015, 2016 and 2017 compared to 2014 (Figure 1B). Opioid prescribing has undergone sizable changes in Maine between 2012 and 2017 with more than a forty-percent reduction in fentanyl, morphine, tapentadol, meperidine, hydrocodone, and oxydocone but a 58% increase in buprenorphine [5]. Other states with opioid prescribing laws have not noticed pronounced opioid reductions [24]. The second opioid wave of drug crimes and overdose deaths involving heroin may be cresting. In Maine, drug charges for heroin peaked in 2016 and were significantly higher in 2016 and 2017 compared to 2014. This pattern in Maine of heroin drug charges is consistent with heroin overdose deaths which also peaked in 2016 and subsequently declined [5]. The third wave of illicit fentanyl use and overdose death poses an alarming and increasing threat to Maine and the US. Drug charges in Maine for fentanyl were significantly higher in 2015, 2016 and 2017 compared to 2014. Likewise, overdose

deaths from illicit fentanyl continue to rise in Maine with 247 fatalities in 2017 compared to only one in 2013 [5].

The adverse impacts from excessive distribution of opioid prescription drugs may be declining in Maine in part due to recent laws that limit opioid doses and mandate use of the PDMP thereby reducing overprescribing and diversion [8]. Maine's opioid prescribing law is unique in the US to include financial penalties for non-adherence [1]. Nonetheless, nonmedical use of opioid prescription drugs remains prevalent especially in older adults (Figure 3A). Complicating the picture, the successful reduction in availability of opioid prescriptions [5] coupled with a lack of available and timely treatment for those with opioid use disorder may be inadvertently contributing to the shift toward cheaper and more easily obtainable heroin and illicit fentanyl. The recent rise in illicit fentanyl arrests and overdose deaths in Maine reflect the dramatic escalation of the opioid epidemic. Only two milligrams of fentanyl is a potentially lethal dose [25]. Recent arrests in Maine and New Hampshire have resulted in the seizure of over 30 kilograms of illicit fentanyl. This is enough to potentially cause 15 million overdoses [26-28] which is over five-fold greater than the population of these states.

There were over eight-hundred arrests for buprenorphine making this mu partial agonist the third most common individual drug reported to the DAP and the most common prescription drug. The preponderance (84%) of buprenorphine arrests were for possession. The median street value for the buprenorphine/naloxone film among Australian persons who inject drugs was \$31 for 8 mg [19]. A US online reporting system lists values in 2019 between \$8-30 for 8 mg [29]. This report extends upon earlier ones [2, 11, 14] and found that buprenorphine accounted for one-tenth of arrests for individuals in their thirties. Given the increased availability of this OUD treatment in Maine [5] and nationwide [1], additional qualitative study of arrestees is needed to determine if this is the result of self-medication, non-medical use [16, 30], or some other factors.

While the current opioid crisis has deservedly garnered significant attention, stimulants remain prevalent, the use of cocaine and crack cocaine appears to have rebounded and non-medical use of

sedatives such as prescription alprazolam is increasing in Maine. Drug arrests for methamphetamine were significantly higher in 2016 and 2017 than 2014 (Figure 1B). Meanwhile, drug arrests for cocaine/crack cocaine and alprazolam were significantly higher in 2017 compared to 2014 in Maine. Drug arrests involving stimulants were significantly more likely among men while drug arrests for sedatives such as alprazolam and non-controlled prescription drugs were significantly higher among women (Figure 3B). The biological or environmental hypothesis that might explain a difference in nonmedical drug use between men and women such that men are more likely to be arrested for stimulants and women are more likely to be arrested for sedatives remains to be determined. Previous exposure to similar prescription drugs has contributed to this phenomenon. Prescription stimulants are indicated for attention deficit hyperactivity disorder which is more prevalent in men whereas sedatives, specifically benzodiazepines, are indicated for anxiety disorders which are more prevalent among women [31, 32]. The increasing prevalence of drug arrests for these substances needs careful monitoring in both sexes. Although naloxone availability has expanded greatly in this state, almost one-third of overdose decedents in Maine tested positive for naloxone [5]. This could imply that either naloxone was administered too late, the dose was insufficient to overcome the mu receptor agonist (e.g. carfentanil), that other substances were involved, or that naloxone was bioavailable via injection of buprenorphine/naloxone. There is also increasing evidence that sublingual administered naloxone in buprenorphine/naloxone products is bioavailable to clinically significant degrees [33]. The arrest data indicate that increased resources for the provision of evidence based interventions [34] for cocaine/crack cocaine may be necessary in the near future.

The arrest information communicated from law-enforcement to medical professionals by the DAP complemented that provided by the state's PDMP [10]. Future modifications and implementation of the DAP in other municipalities could include: 1) raising the profile of this type of harm-reduction tool with relevant stake-holders; 2) integration of a DAP with the PDMP so that busy health care providers do not need to register and access multiple databases; 3) mandatory data uploading to a secure server from

all local, county, and tribal law enforcement agencies; 4) inclusion of arrest information about minors (≥ 16) or arrestee ethnicity to better characterize the needs of diverse populations; 5) differentiation of pharmaceutical versus illicit formulations (e.g. for fentanyl); 6) identification of a stable funding source; and 7) availability of updated (i.e. post-arrest) information about the analytical chemistry of drugs (i.e. there are serious concerns about the transparency, limit of detection, selectivity and specificity of the “spot” or field tests [35]) and final judicial outcomes.

Over four-fifths of benzodiazepine arrests were for possession. In contrast, possession was less common than trafficking for marijuana. Further study is needed to better understand the generalizability of the findings in Figure 2 as other states have different offense criteria. The weight disparity for cocaine versus crack cocaine continues to warrant further attention as the so-called “Fair” Sentencing Act of 2010 only attenuated the disparities for crack cocaine versus cocaine [36].

This report extends and integrates findings from prior single-year reports [5, 11, 13, 14]. Some caveats with the DAP have been discussed previously [11]. Briefly, this well powered dataset identified some findings, for example males accounted for 2.3% more stimulant arrests, which, although statistically significant, might be of limited value for health care providers. Sex differences in criminal justice system involvement, and also overdoses, may be becoming less pronounced. It would be of substantial value if DAP included information about the formulation so as to know which ones were most common among the eight-hundred buprenorphine arrests. This data, as well as that obtained by others [20], indicates that the nonmedical use potential of buprenorphine should be clearly emphasized in X-waiver trainings. State laws may limit the generalizability of select findings to other areas. For example, Maine approved medical cannabis in 1999 and recreational marijuana in 2016 which likely contributed to the low occurrence of arrests for marijuana possession. The limited ethnic diversity of Maine is another important consideration. The age ranges at the extremes (i.e. 18-29, ≥ 60) were not equivalent in terms of years covered or the number of arrestees which could have a minor impact on the results. This dataset was deidentified for investigative purposes which precluded examination of arrests among repeat offenders.

Further, arrests reflect a combination of use patterns and law enforcement priorities. This pharmacoepidemiology index could be viewed as complementing anonymous surveys, prescriptions of licit drugs, emergency room visits, and medical examiner reports.

In conclusion, this multiyear study reveals a complex and evolving nonmedical drug use patterns. Heroin and illicit fentanyl are the greatest concerns while prescription opioid nonmedical use remains a persistent problem. Recent increases in cocaine/crack cocaine, methamphetamine, and alprazolam related crimes may signal the emergence of new patterns of non-medical drug use that warrant further monitoring. The overall drug situation continues to worsen as evidenced by rising overdose deaths and further national public health policy initiatives are needed to reverse these trends.

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