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# Associations of clinical personnel characteristics and controlled substance prescribing practices

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## Abstract

**Context:** Over 68,000 deaths were attributed to opioid-related overdose in 2020. Evaluative studies have shown that states that utilized Prescription Drug Monitoring Program (PDMP) systems have decreased opioid-related deaths. With the growing use of PDMPs and an ongoing opioid epidemic, determining the demographics of physicians at risk of overprescribing can elucidate prescribing practices and inform recommendations to change prescribing behaviors.

**Objectives:** This study aims to assess prescribing behaviors by physicians in 2021 based on four demographics utilizing the National Electronic Health Record System (NEHRs): physician's age, sex, specialty, and degree (MD or Doctor of Osteopathic Medicine [DO]).

**Methods:** We performed a cross-sectional study of the 2021 NEHRs to determine the relationship between physician characteristics and PDMP use on opioid-prescribing behaviors. Differences between groups were measured via design-based chi-square tests. We constructed multivariable logistic

regression models to assess the relationships, via adjusted odds ratios (AOR), between physician characteristics and alternate prescribing patterns.

**Results:** Compared to female physicians, male physicians were more likely to alter their original prescription to reduce morphine milligram equivalents (MMWs) prescribed for a patient (AOR: 1.60; CI: 1.06–2.39;  $p=0.02$ ), to change to a non-opioid/nonpharmacologic option (AOR: 1.91; 95 % CI: 1.28–2.86;  $p=0.002$ ), to prescribe naloxone (AOR=2.06;  $p=0.039$ ), or to refer for additional treatment (AOR=2.07; CI: 1.36–3.16;  $p<0.001$ ). Compared to younger physicians, those over the age of 50 were less likely to change their prescription to a nonopioid/nonpharmacologic option (AOR=0.63; CI: 0.44–0.90;  $p=0.01$ ) or prescribe naloxone (AOR=0.56, CI: 0.33–0.92;  $p=0.02$ ).

**Conclusions:** Our results showed a statistically significant difference between specialty category and frequency of prescribing controlled substances. After checking the PDMP, male physicians were more likely to alter their original prescription to include harm-reduction strategies. Optimizing the use of PDMP systems may serve to improve prescribing among US physicians.

**Keywords:** controlled substances; National Electronic Health Record System (NEHRs); opioid; physician characteristics; prescription drug monitoring program (PDMP).

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Since the mid-1990s, the increasing rate of opioid prescribing in the United States has perpetuated the consequent rise in opioid-related morbidity and mortality owing to both prescription opioid overprescription, and misuse [1, 2]. Overprescription is a process of prescribing in excess of what is needed to treat the targeted symptoms and may lead to serious adverse events such as drug poisoning [3]. In 2015, approximately 78,840 Americans were hospitalized for opioid poisoning [3]. Furthermore, in 2020, over 68,000 deaths were attributed to opioid-related overdose [4, 5]. Mitigative efforts by US policymakers included pain clinic laws and prescription limit laws to reduce inappropriate prescribing behavior [6]. This led to declines in prescription rates from 78.1 to 43.4 per 100 people between 2013 and 2020 [7]. Additionally, in the 5 years between 2013 and 2017,

the amount of high dosage pain medications prescribed, fell from 7.6 to 5 per 100 people [8]. Despite these efforts, the opioid epidemic and associated overprescribing brought with it an immense financial burden, costing the United States over \$1 trillion in 2017 alone [9]. Additional targeted efforts to address the rising opioid epidemic and associated financial and healthcare burden included the conceptualization and development of the Prescription Drug Monitoring Program (PDMP) [10].

The PDMP was first introduced as a statewide electronic database that would track the prescription of controlled substances in an effort to curtail overprescribing, inhibit doctor shopping, and reduce unintended injury or death associated with opioid overdose in the United States [10, 11]. PDMPs collect and store data on all Schedule II, III, and IV controlled substances received by an individual [10, 11]. With this data, an individual seeking opioids from different providers may be easily identified and prevented from receiving multiple opioid prescriptions at the same time or in close sequence [10]. In 2016, an evaluative study involving 34 states showed that states that utilized PDMP systems decreased opioid-related deaths the following year, with a sustained 30 % reduction in the rate of prescribed Schedule II opioids [12]. The implementation of the PDMP and other databases has shown that 49 % of opioid dosages, as well as 27 % of opioid prescriptions, come from 1 % of opioid prescribers [13]. Nearly one quarter of the 1 % were family medicine physicians, which represented the largest specialty among the 1 % [13]. Similarly, Rochon et al. [14] conducted a population-based retrospective cohort study utilizing administrative healthcare data from April 1, 2010 to June 30, 2016 to assess whether male and female physicians differed in their prescribing practices for dementia management. The analysis included 3,443 female and 5,811 male physicians and found a statistically significant difference in prescribing patterns between female and male physicians, suggesting that female physicians may be more careful and conservative in their approaches [14]. Given the potential disparity in reported prescribing behaviors, further studies are needed to investigate the associations between physician characteristics and prescribing behavior.

The primary objective of this study is to assess prescribing behaviors by physicians during 2021 based on four demographics utilizing the National Electronic Health Record System (NEHRS): physician's age, sex, specialty, and degree (MD or Doctor of Osteopathic Medicine [DO]). With the opioid epidemic still ongoing, determining specific demographics at the risk of overprescribing can lead to better understanding of prescribing practices and allow for recommendations to change prescribing behaviors.

Physicians' use of a PDMP allows them to see a patient's past medication history and aims to prevent overprescribing and opioid misuse [12]. Therefore, our secondary aim is to assess reported prescribing behaviors in association with physician PDMP use.

## Methods

### Data source

We utilized the NEHRS dataset to perform a cross-sectional study to determine the relationship between physician characteristics and PDMP use on opioid-prescribing behaviors. The NEHRS is a national survey, conducted by the National Center for Health Statistics (NCHS) and sponsored by the Office of the National Coordinator for Health Information Technology (ONC) of office-based physicians in the United States, conducted annually utilizing web, mail, and telephone [15]. The NEHRS is utilized to estimate the adoption of state and national electronic health records (EHRs), capabilities of EHRs, and burden associated with EHRs [15]. Data collected through the NEHRS are utilized by the NCHS to publish reports and web tables to detail the adoption of EHRs [15].

### Eligibility

We analyzed NEHRS data from 2021 to examine physician prescribing patterns of controlled substances as reported by respondent physicians. The NEHRS captured controlled substance prescribing data from 1875 physicians in 2021 [16].

The outcomes of interest were the controlled substances prescribing practices by physicians for three questions. The first two were "How frequently do you prescribe controlled substances?" and "How frequently do you or designated staff check your state's prescription drug monitoring program (PDMP) prior to prescribing a controlled substance to a patient for the first time?" Responses for these questions were "Often," "Sometimes," "Rarely," "Never," and "Don't know." All respondents who answered "Don't know" to the former question were excluded for all outcomes of interest.

To assess the impact of checking a PDMP resulting in alternate prescribing patterns, we extracted data for the question "Have you done any of the following as a result of utilizing the PDMP?" Of the nine response options, we utilized the first four because they were relevant to changing prescribing intention: (1) "Reduced or eliminated controlled substance prescriptions for a patient"; (2) "Changed controlled substance prescriptions to nonopioid pharmacologic (e.g., NSAIDs or acetaminophen) or nonpharmacologic therapy (e.g., exercise/physical therapy or CBT)"; (3) "Prescribed naloxone"; and (4) "Referred additional treatment (e.g., substance abuse treatment, psychiatric or pain management)."

### Demographic measures

Physician demographic characteristics extracted from NEHRS included physician age (under 50 and 50+), sex (female or male), type of degree

(MD or DO), and specialty field (primary care, surgical, medical). Primary care specialty includes physicians reporting as family medicine, internal medicine, and obstetric. Examples of surgical specialties include general surgery, plastic surgery, and otolaryngology. Medical specialties included addiction medicine, pain management, and emergency medicine. All responses reported as “blank” or “not applicable” were excluded from the analysis.

### Statistical analysis

Prior to analysis, we applied the survey design and weighting, provided by NEHRS. First, we reported the number of physicians in the sample (n), the national estimate (n), and the weighted percentages for physician characteristics—age, sex, specialty, and degree. Then we calculated the weighted percentages of the reported frequencies of (1) controlled substance prescribing, and (2) checking state PDMP by physician characteristics. Differences between groups were measured via design-based chi-square tests. Next, we constructed multivariable logistic regression models to assess the relationships between physician characteristics and alternate prescribing patterns via adjusted odds ratios (AOR).

## Results

### Study demographics

Our analysis of the NEHRS included 1,465 physicians responding to questions regarding controlled substances during the 2021 cycle. Of these physicians, 991 (68.9 %) were males and 474 were females (31.1 %) (Table 1). Physicians age 50 and over accounted for 940 responses (67.5 %), and physicians under the age of 50 accounted for 525 responses (32.5 %). Regarding medical specialties, primary care physicians accounted for the most responses with 803 responses (50.7 %), followed by medical physicians with 361 responses (29.4 %) and surgical physicians with 301 responses (19.9 %). Finally, allopathic (MD) physicians accounted for 1,351 responses (93.2 %), while osteopathic (DO) physicians accounted for 114 responses (6.8 %).

### Primary outcomes

Male physicians frequently prescribed controlled substances 30.5 % of the time, and female physicians frequently prescribed controlled substances 22.4 % of the time; however, this comparison was not statistically significant ( $X^2=2.18$ ;  $p=0.09$ ) (Table 2). Male physicians checked the PDMP database prior to prescribing controlled substances 70.2 % of the time and females checked it 66.5 % of the time.

**Table 1:** Demographic characteristics of physicians represented in NEHRS responding to questions regarding the use of PDMPs.

Characteristic	n; n	Weighted %
Sex		
Female	474; 96,597	31.10
Male	991; 214,053	68.90
Age, years		
<50	525; 100,987	32.51
50+	940; 209,663	67.49
Specialty category		
Primary care	803; 157,534	50.71
Surgical	301; 61,803	19.89
Medical	361; 91,314	29.39
Degree		
Allopathic (MD)	1,351; 289,659	93.24
Osteopathic (DO)	114; 20,991	6.76

DO, Doctor of Osteopathic Medicine; NEHRS, National Electronic Health Record System; PDMP, prescription drug monitoring program.

This comparison was also not statistically significant ( $X^2=1.5$ ;  $p=0.21$ ). There were no significant differences between the age groups of physicians in controlled drug prescribing frequency ( $X^2=0.41$ ,  $p=0.75$ ) nor in the frequency of checking PDMP before prescribing a controlled substance ( $X^2=0.47$ ,  $p=0.70$ ). There were also no differences in the type of degree (allopathic physicians compared to osteopathic physicians) and the frequency of prescribing controlled drugs by ( $X^2=1.77$ ;  $p=0.15$ ) or how often these physicians checked their state’s PDMP prior to prescribing a controlled substance to a patient for the first time ( $X^2=1.89$ ;  $p=0.14$ ).

There was an observable, statistically significant, difference between specialty category and frequency of prescribing rates of controlled substances ( $X^2=12.98$ ;  $p<0.001$ ). Among those in the surgical specialty, 34.58 % reported prescribing frequently compared to 29.7 % in primary care and 21.2 % in Medical specialties. Further, 19.58 % of physicians in medical specialties reported never prescribing, whereas only 1.94 % reported never prescribing in primary care. Among all specialties, the rate at which physicians reported frequently checking the state’s PDMP was approximately 70 %, and although not statistically significant, physicians in surgery specialties only checked their state’s PDMP prior to prescribing a controlled substance 61.2 % of the time compared to primary care physicians at 70.8 % and medical specialists at 71.3 %.

**Table 2:** Frequency of prescribing controlled drugs and usage of drug monitoring program by physician demographics.

How frequently do you prescribe controlled substances?					
Characteristic	Frequently (%)	Sometimes (%)	Rarely (%)	Never (%)	Design-based X <sup>2</sup> Test-value, p
Sex					
Female	22.4	42.91	23.52	11.16	2.18, 0.09
Male	30.52	34.84	24.68	9.96	
Age, years					
<50	27.09	38.02	26	8.89	0.41, 0.75
50+	28.31	37.14	23.51	11.04	
Specialty category					
Primary care	29.72	47.45	20.89	1.94	12.98, <0.001
Surgical	34.58	31.88	19.37	14.17	
Medical	21.17	27.03	32.22	19.58	
Degree					
Allopathic (MD)	28.2	37.43	23.68	10.69	1.77, 0.15
Osteopathic (DO)	23.25	37.4	34.79	4.56	
<b>How frequently do you or designated staff check your state's prescription drug monitoring program (PDMP) prior to prescribing a controlled substance to a patient for the first time?</b>					
Sex					
Female	66.45	16.47	6.97	10.11	1.5, 0.21
Male	70.2	12.48	9.78	7.54	
Age, years					
<50	71.15	12.66	7.34	8.85	0.47, 0.70
50+	67.97	14.26	9.65	8.12	
Specialty category					
Primary care	70.83	14.6	7.25	7.31	1.93, 0.08
Surgical	61.16	13.82	15.49	9.52	
Medical	71.26	12.23	7.19	9.32	
Degree					
Allopathic (MD)	68.63	13.49	9.06	8.81	1.89, 0.14
Osteopathic (DO)	74.67	17.4	6.37	1.56	

DO, Doctor of Osteopathic Medicine.

## Secondary outcomes

After checking PDMP, male physicians were more likely to alter their original prescription to reduce/eliminate prescriptions for a patient (AOR: 1.60; 95 % CI: 1.06–2.39;  $p=0.02$ ), change to a nonopioid/nonpharmacologic option (AOR: 1.91; 95 % CI: 1.28–2.86;  $p=0.002$ ), prescribe naloxone (AOR=2.06;  $p=0.039$ ), or refer an additional treatment (AOR=2.07; 95 % CI: 1.36–3.16;  $p<0.001$ ) compared to female

physicians (Table 3). After checking PDMP, physicians over the age of 50 years old were less likely to change their prescription to a nonopioid/nonpharmacologic option (AOR=0.63; 95 % CI: 0.44–0.90;  $p=0.01$ ) or prescribe naloxone (AOR=0.56, 95 % CI: 0.33–0.92;  $p=0.02$ ) compared to physicians under the age of 50. Compared to physicians in primary care, after checking PDMP, surgical physicians were significantly less likely to alter their original prescription by prescribing naloxone (AOR=0.09; 95 % CI: 0.04–0.21;  $p=0.001$ ) or refer

their patients for an additional treatment (AOR=0.26; 95 % CI: 0.14–0.50; p<0.001). Additionally, physicians in medical specialties were significantly less likely to change prescriptions to nonopioid/nonpharmacologic options after checking PDMP compared to primary care physicians (AOR=0.61; 95 % CI: 0.39–0.94; p=0.025). Finally, we found no associations between allopathic (MD) and osteopathic (DO) physicians' prescribing patterns after they had checked their state's PDMP.

## Discussion

We examined the association between physician's age, sex, specialty, and degree on prescribing patterns and PDMP use. Overall, we found that almost 17 % of physicians reported rarely or never checking their state's PDMP prior to initiating an opioid prescription for a first visit. Our results

showed nearly one-third of surgical physicians reported that they prescribe opioids frequently, yet they utilized PDMP at a lower rate than primary care and medical physicians. In addition, we found that nearly 30 % of physicians in medical specialties were likely to change prescriptions to nonopioid/nonpharmacologic options after checking the PDMP compared to 38 % of primary care physicians. We also found that physicians over 50 were less likely to change prescriptions to nonopioid/nonpharmacologic options after checking the PDMP compared to physicians under 50, and female physicians are less likely to reduce their initial opioid prescription than male physicians after checking the PDMP. Finally, we found that female physicians are less likely to prescribe naloxone and also less likely to refer to additional treatment. Given these differences in prescribing behavior among multiple characteristics, we have provided a basis for further research into this topic.

**Table 3:** Associations of physician characteristics and likelihood to alter prescribing habits after checking prescription drug monitoring program.

Characteristic	Reduced/eliminated prescriptions for a patient			Changed prescriptions to nonopioid/nonpharmacologic			Prescribed naloxone			Referred additional treatment <sup>a</sup>		
	Yes, %	AOR (95 % CI)	t, p-Value	Yes, %	AOR (95 % CI)	t, p-Value	Yes, %	AOR (95 % CI)	t, p-Value	Yes, %	AOR (95 % CI)	t, p-Value
<b>Sex</b>												
Female	52.64	1 (ref)	–	28.74	1 (ref)	–	12.78	1 (ref)	–	22.73	1 (ref)	–
Male	61.13	<b>1.60 (1.06–2.39)</b>	<b>2.26, 0.024</b>	39.99	<b>1.91 (1.28–2.86)</b>	<b>3.16, 0.002</b>	13.54	<b>1.77 (1.03–3.04)</b>	<b>2.06, 0.039</b>	30.33	<b>2.07 (1.36–3.16)</b>	<b>3.40, 0.001</b>
<b>Age, years</b>												
<50	62.19	1 (ref)	–	41.78	1 (ref)	–	17.72	1 (ref)	–	30.08	1 (ref)	–
50+	56.71	0.74 (0.50–1.07)	–1.6, 0.11	33.94	<b>0.63 (0.44–0.90)</b>	<b>–2.51, 0.012</b>	11.18	<b>0.56 (0.33–0.92)</b>	<b>–2.27, 0.023</b>	26.94	0.78 (0.53–1.15)	–1.27, 0.21
<b>Specialty category</b>												
Primary care	59.46	1 (ref)	–	38.15	1 (ref)	–	17.86	1 (ref)	–	33.37	1 (ref)	–
Surgical	60.66	0.91 (0.56–1.47)	–0.39, 0.70	42.92	1.05 (0.66–1.65)	0.2, 0.84	2.23	<b>0.09 (0.04–0.21)</b>	<b>–5.52, &lt;0.001</b>	14.23	<b>0.26 (0.14–0.50)</b>	<b>–4.06, &lt;0.001</b>
Medical	55.36	0.77 (0.51–1.16)	–1.24, 0.22	29.28	<b>0.61 (0.39–0.94)</b>	<b>–2.24, 0.025</b>	12.93	0.61 (0.33–1.12)	–1.61, 0.11	27.93	0.67 (0.43–1.05)	–1.77, 0.08
<b>Degree</b>												
Allopathic (MD)	58.44	1 (ref)	–	35.71	1 (ref)	–	13.46	1 (ref)	–	27.53	1 (ref)	–
Osteopathic (DO)	59.27	0.96 (0.52–1.79)	–0.12, 0.91	47.30	1.50 (0.82–2.76)	1.31, 0.19	11.19	0.62 (0.27–1.42)	–1.14, 0.25	33.94	1.04 (0.57–1.90)	0.14, 0.89

<sup>a</sup>Additional treatment including substance use treatment, psychiatric services, or pain management. AOR, adjusted odds ratio; CI, confidence interval; DO, Doctor of Osteopathic Medicine.

## Male and female physicians

We found significant differences between male and female physicians across multiple facets of opioid prescribing—which is interesting given that the Association of American Medical Colleges (AAMC) showed that 81 % of all pain medicine and pain management physicians in 2019 were male, which is significantly higher than 63.7 % for all specialties combined [17]. The data show that the most common source by which individuals seeking to obtain and illegally sell opioid prescriptions was through pain management clinics [18]. Consequently, we found that female physicians were less likely to change their initial prescription after checking the PDMP, which may be related to a 2022 study that found female physicians prescribe a lower average dose (22.8 morphine milligram equivalents [MME]) of opioids than males at (29.1 MME), and male physicians prescribe opioids at higher rates [19]. Given these statistics, male physicians may be more sought after by individuals with opioid use disorders (OUD) [19]. With these findings, it is important that the use of PDMPs, by male physicians especially, is optimized in order to identify individuals who might be experiencing OUD and refer them to additional treatment.

Our findings among female physicians could suggest that female physicians are more attuned to their patient needs, leading to more efficient and patient-centered care. A 2017 study on hospital mortality and readmission rates in Medicare patients showed that female physicians had significantly lower mortality rates compared to male physicians. Moreover, among over 1.5 million hospital visits, female physicians had lower readmission rates, at 15.02 %, while male physicians had readmission rates of 15.57 % [20]. Additionally, a 2022 study showed that for female physicians, as clinical encounter scores increased, the likelihood of prescribing opioids decreased—for every 10 % increase in clinical encounter score, there was a 16 % decrease in the likelihood of prescribing an opioid medication. However, this relationship was only observed among female physicians [21]. Although beyond the reach of our analysis, training opportunities to increase clinical encounter scores among male and female physicians might support efforts to manage opioid-prescribing rates among physicians.

## Physician specialties

There are multiple notable findings regarding opioid-prescribing patterns comparing physicians of different specialties. We found that surgeons reported prescribing controlled substances more frequently than primary care or

medical specialty physicians, which we attribute to the need for pain relief from surgical procedures. Although not statistically significant, upon initiation of a controlled substance prescription, surgical specialties checked their state's PDMP less frequently compared to primary care and medical specialties. The less frequent initial PDMP use by surgical specialties is consistent with previous studies showing statistically significant differences between the PDMP use of surgeons compared to primary care physicians [22]. In addition, our analysis showed that surgeons were less likely to alter prescribing habits after checking PDMPs by prescribing naloxone or referring for additional treatment.

These differences in controlled substance prescriptions between specialties may be due to the varied clinical scenarios experienced by surgical specialties compared to medical and primary care specialties. Also, gender predominance in specific specialties could play a role in prescribing patterns. However, despite these differences, PDMP use may still have a role to play in the treatment of postoperative patients. A study found that even nonchronic preoperative opioid prescriptions correlated with prolonged postoperative opioid prescriptions [23]. Another explanation for surgical specialties less frequently altering prescribing habits after checking PDMPs is a lack of access or inadequate access to education regarding resources to treat patients with OUD [24]. Goel et al. [24] found that in a study of 39 surgeons, more than half of the surgeons in their study were unaware of programs for patients with suspected OUD, and only 13 % of the surgeons believed services for those patients are easy to access. However, by identifying people who might be in crisis, clinicians can lead those folks to services rather than further contribute by offering additional prescription of a controlled substance. Thus, despite different clinical circumstances between surgical specialties and primary care specialties, interventions and programs that include education regarding OUD, risk factors for developing OUD, and its treatment are warranted. In addition, incorporating and increasing PDMP use during postoperative management for surgical specialties is still likely to be beneficial [23].

## Physician age

Finally, our analysis also showed that physicians under the age of 5 years old were more likely to alter their prescribing habits by changing prescriptions to a nonopioid/non-pharmacologic or by prescribing naloxone, compared to those physicians 50 years old or older. Differences in the prescribing habits of controlled substances based on age may be due to younger physicians undergoing or having

completed their residency training during the ongoing opioid epidemic [25]. Also, recent changes in the Accreditation Council for Graduate Medical Education (ACGME) prescribing guidelines have mandated education in pain and addiction, leading to a greater willingness to consider and choose alternatives to opioid medications based on greater firsthand experience with OUD. A study of 228 trainees and 361 attending physicians showed that primary care trainee physicians were more likely (76.3%) than attending physicians (67.1%) to view opioid use medications as effective and to express interest in treating patients with OUD. In addition, they expressed greater support than attending physicians for policies easing barriers to prescribing medications to treat OUD [25]. Our results showed no significant difference between age groups in the frequency of checking PDMP prior to prescribing a controlled substance to a patient for the first time, which suggests that our findings may be due to disparities in knowledge or comfort regarding the treatment of patients with OUD.

## Physician degree

There was no significant finding between PDMP use, prescribing patterns, and physician degree. These results indicate that both DO and MD physicians are prescribing opioids at similar rates. Ensuring that all physicians are equipped to identify, treat, and reduce harms associated with OUD is essential to proper patient care. Osteopathic physicians are poised to assist in managing common pain patterns experienced by patients with the use of osteopathic manipulative treatment (OMT). Soft-tissue techniques, counterstrain, and myofascial release could all be beneficial techniques for chronic pain management if integrated into the management plan by osteopathic physicians in practice. The use of OMT in pain management care, along with the expanded use of other physical and manual therapies, could mitigate the use of opioids to manage pain. In addition, the expanded use of PDMP systems to guide physician behaviors when initiating or continuing prescriptions for controlled substances should be emphasized in both degree pathways.

## Strengths and limitations

A strength of this study is that the dataset provided a large enough sample size that allowed for sufficient statistical strength of data analysis. Regarding limitations, because the study design was cross-sectional, it is difficult to determine causal inference. However, the choice of study design was

appropriate because cross-sectional studies are useful in determining multiple associations in an efficient manner. Self-report biases and limited information on state use posed another limitation. The wording of questions by NEHRS leaves a margin for interpretation of questions regarding frequency of prescribing, which could skew data. Additionally, selection bias, social desirability bias, and the smaller sample sizes for the DO subgroup and female subgroup are added limitations of the NEHRS dataset.

The NEHRS also does not provide specific subspecialties categories, that is, surgical subspecialties such as orthopedic surgery, genitourinary reconstructive surgery, and so on. Further, laws regarding the use of PDMPs may differ by state. Future studies should examine the patterns of PDMP use and prescribing patterns by specific subspecialties and by state in order to identify whether disparities exist between specialties and by state. Nevertheless, this study highlights the physician characteristics that are associated with PDMP use and the effect of the PDMP on the prescribing patterns of controlled substances. Ongoing efforts should focus on optimizing the use of PDMP systems among US physicians.

## Conclusions

Our results showed a statistically significant difference between specialty category and frequency of prescribing controlled substances, with surgical specialties prescribing the most frequently. Additionally, after checking the PDMP, male physicians were more likely to alter their original prescription compared to female physicians. Thus, optimizing and expanding the use of PDMP systems among all specialties may serve to improve prescribing behaviors among US physicians. In addition, physician training in how to identify, manage, and treat OUD, coupled with increased use of OMT, could benefit the ongoing efforts to control the rise in opioid-related morbidity and mortality in the United States.

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