



Opioid prescribing by dentists in Medicare Part D: national trends and geographic variation

Prescripción de opioides por odontólogos en Medicare Parte D: tendencias nacionales y variación geográfica

Rigel Ramirez Fritze¹  

Arlin Castro Diaz²  

¹ Rutgers School of Dental Medicine, USA.

² Universidad Iberoamericana Santo Domingo. Santo Domingo, República Dominicana.

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Corresponding Author: Arlin Castro Diaz 

ABSTRACT

Introduction: Dentists are an important source of opioid prescriptions in the United States, but recent national and state-level trends in dental opioid prescribing to Medicare Part D beneficiaries are poorly quantified. **Methods:** We analyzed the public CMS Medicare Part D Prescribers by Provider dataset for 2013-2021, restricted to prescribers of type Dentist in the 50 states and the District of Columbia. Outcomes were annual opioid claims, the opioid prescribing rate per 100 total claims, opioid claims per dentist, the proportion of dentists with at least one opioid claim, and long-acting opioid share. Suppressed counts (1-10) were imputed at the midpoint with bounds of 1 and 10. Trends used log-linear regression; state variation used the coefficient of variation and Spearman correlation. **Results:** The analysis included 1,149,905 dentist-year records and 81,539,159 total claims. Opioid claims declined from 1,431,237 to 1,162,416, and the opioid rate fell from 18.8 to 11.0 per 100 claims (-41.3%), an annual percent change of -6.8% (95% CI -7.92 to -5.61). Dentists with at least one opioid claim declined from 84.1% to 64.8%. In 2021 state rates ranged from 4.1 (Maine) to 22.9 (Mississippi) per 100 claims; the coefficient of variation rose from 27.8% to 41.7%, and state rankings were stable (Spearman rho 0.88). **Conclusions:** Opioid prescribing by dentists to Medicare Part D beneficiaries declined substantially from 2013 to 2021, but marked and persistent state-level variation remains.

Keywords: Analgesics; Opioid; Dentists; Medicare Part D; Drug Prescriptions; Practice Patterns; Dentists; United States.

RESUMEN

Introducción: Los odontólogos son una fuente importante de prescripciones de opioides en Estados Unidos, pero las tendencias recientes de la prescripción dental de opioides a beneficiarios de Medicare Parte D están poco cuantificadas. **Métodos:** Se analizó el conjunto público Medicare Part D Prescribers by Provider de CMS (2013-2021), restringido a prescriptores de tipo Dentist. Los desenlaces fueron las reclamaciones anuales de opioides, la tasa por 100 reclamaciones totales, la proporción de odontólogos con al menos una reclamación de opioides y la proporción de opioides de acción prolongada. Los conteos suprimidos se imputaron en el punto medio. Las tendencias usaron regresión log-lineal y la variación estatal el coeficiente de variación y la correlación de Spearman. **Resultados:** El análisis incluyó 1 149 905 registros y 81 539 159 reclamaciones. Las reclamaciones de opioides bajaron de 1 431 237 a 1 162 416, y la tasa cayó de 18,8 a 11,0 por 100 reclamaciones (-41,3 %). Los odontólogos con opioides bajaron de 84,1% a 64,8%. En 2021 las tasas estatales oscilaron entre 4,1 (Maine) y 22,9 (Misisipi); el coeficiente de variación subió de 27,8 % a 41,7 % (rho de Spearman 0,88). **Conclusiones:** La prescripción de opioides por odontólogos a beneficiarios de Medicare Parte D disminuyó de 2013 a 2021, pero persiste una variación estatal marcada.

Palabras clave: analgésicos opioides; odontólogos; Medicare Parte D; prescripciones de medicamentos; pautas de práctica odontológica; Estados Unidos.

INTRODUCTION

The United States has experienced a prolonged crisis of prescription opioid misuse and overdose that has unfolded in successive waves and has not abated even as prescribing declined.(1,2) After more than a decade of rising opioid prescribing, national volumes peaked in the early 2010s and then fell, yet opioid-involved overdose deaths continued to climb, driven increasingly by illicit opioids.(3) These opposing trajectories of prescribing and harm have been tracked closely in national surveillance, which uses prescribing volume as its primary indicator.(3) Because most people who misuse prescription opioids first receive them through a medical prescription, identifying which providers initiate opioid exposure and how their prescribing changes over time remains central to prevention.(2)

Dentists are among the leading sources of outpatient opioid prescriptions in the United States, accounting for roughly 1 in 10 opioid prescriptions written nationally.(4,5) Dental prescribing is concentrated in the management of acute, mostly postsurgical, dental pain, a condition for which nonsteroidal anti-inflammatory drugs are at least as effective.(5) The exposure is not trivial: opioid prescriptions from dental clinicians have been associated with subsequent opioid misuse and serious opioid-related adverse events, particularly in adolescents and young adults.(6,7) Recognition of the problem is longstanding, and dentistry-specific prevention strategies were proposed more than a decade ago.(8)

National studies of commercial and Medicaid populations have documented a steady decline in dental opioid prescribing concentrated after the mid-2010s.(9-12) The decline has been attributed to several converging interventions: the 2014 rescheduling of hydrocodone, the 2016 Centers for Disease Control and Prevention (CDC) guideline for opioid prescribing, state prescription duration limits, prescription drug monitoring programs, and professional education.(13-16) International comparisons illustrate the scale of the problem: dentists in the United States prescribed substantially more opioids than their counterparts in England.(17)

For the Medicare population, the evidence is thinner. One study described opioid prescribing by dentists to Part D beneficiaries through 2015,(18) and analyses of Part D opioid prescribing have generally aggregated all provider types rather than isolating dentists.(19,20) Geographic variation in opioid prescribing is well documented for prescribers overall,(21-23) but whether state-level variation in dental opioid prescribing is equally marked, and whether it narrowed as national rates fell, has not been established for the Medicare Part D population through 2021. National dental prescribing studies also end in 2019 or earlier,(10,24) leaving the most recent pre-pandemic and pandemic years unexamined in a national Medicare frame.

The objective of this study was to quantify national trends and state-level geographic variation in opioid prescribing by dentists to Medicare Part D beneficiaries in the United States from 2013 through 2021. We hypothesized that the national opioid prescribing rate of dentists declined over the study period (H1), that the proportion of dentists who prescribed at least one opioid declined (H2), and that state-level opioid prescribing rates showed substantial variation that persisted across the study period (H3).

METHODS

Study design and data source

We conducted a retrospective ecological time-series and cross-sectional analysis of national, publicly available administrative data on Medicare Part D prescription drug events, following the RECORD reporting recommendations for studies using routinely collected health data.(25) The unit of observation was the individual prescriber within a calendar year, aggregated to the national and state levels for analysis. Data were obtained from the Centers for Medicare and Medicaid Services (CMS) Medicare Part D Prescribers by Provider dataset, which is derived from prescription drug event records submitted by Part D plan sponsors and aggregates, for each prescribing provider and calendar year, the number of drug claims (original prescriptions and refills) and the associated beneficiaries and costs.(26) We retrieved data for calendar years 2013 through 2021 from the data.cms.gov application programming interface, restricting records at the source to prescribers with a provider type of Dentist and selecting the prescriber identifier, prescriber state, total claims, opioid claims, long-acting opioid claims, and opioid prescribing rate fields.(27) In this dataset, a claim corresponds to a prescription fill event and includes original prescriptions and refills for any Part D drug, and each prescriber-year record is a distinct provider identified by a national provider

identifier.

Study population

Records were limited to unique prescribers located in the 50 US states and the District of Columbia. Records from US territories, from military or other non-state address codes, and prescribers without a valid state were excluded. Within each year, duplicate provider identifiers were removed. No records were excluded on the basis of prescribing volume, and prescribers with no opioid claims were retained. This yielded the dentist-year records described in Table 1.

Variables and outcomes

The main exposure was calendar year, and the geographic unit for the cross-sectional component was the prescriber's state. Total claims were defined as the total number of Part D drug claims attributed to a prescriber in a year. Opioid claims and long-acting opioid claims were the corresponding counts for opioid and long-acting opioid drugs, classified by CMS using the drug's national drug code and its opioid or long-acting opioid designation.⁽²⁷⁾ Each hypothesis was operationalized with a prespecified variable, measure, statistical test, and decision criterion. For H1, the primary measure was the annual opioid prescribing rate, defined as 100 times the ratio of total opioid claims to total claims and expressed as opioid claims per 100 total claims; a secondary measure was the mean opioid claims per dentist. The statistical test was a log-linear regression of the annual rate on year, and H1 was considered supported if the annual percent change was negative with a 95% confidence interval that excluded zero. For H2, the measure was the annual proportion of dentists with at least one opioid claim, tested with the Cochran-Armitage trend test; H2 was considered supported if the trend was negative at the two-sided 0.05 level. For H3, the measures were the dispersion of the 51 state-level rates, summarized by the coefficient of variation and the maximum-to-minimum ratio, and their temporal stability, summarized by the Spearman rank correlation between the 2013 and 2021 state rates; H3 was considered supported if dispersion remained substantial across years and the rank correlation was positive and significant. Because CMS suppresses aggregated counts based on 1 to 10 events to protect privacy, opioid and long-acting opioid counts recorded as blank were imputed at the midpoint of the suppression interval (5.5) as the primary estimate; total claims are not suppressed and were used as recorded. The prescribing rate is a claims-based measure and does not incorporate morphine milligram equivalents or days of supply, which are not available in the provider-level file.

Statistical analysis

Annual national totals, rates, and proportions were tabulated for 2013 through 2021. To test H1, we fitted a log-linear ordinary least squares regression of the natural logarithm of the annual opioid prescribing rate on calendar year and derived the annual percent change (APC) as 100 times ($\exp(\beta) - 1$), with a 95% confidence interval constructed from the t distribution with seven degrees of freedom; the same model was applied to the annual opioid claims per dentist and to the sensitivity-bound series described below. To test H2, we used the Cochran-Armitage trend test for the proportion of dentists with at least one opioid claim across the ordered study years; this test is appropriate for a binary outcome observed across ordered categories and does not require the proportions to be independent of the unit totals, which grow over time as the number of dentists increases. To test H3, we computed, for each year, the median, the 10th and 90th percentiles, the interquartile range, the minimum, the maximum, the maximum-to-minimum ratio, and the coefficient of variation of the 51 state-level rates, and we estimated the Spearman rank correlation between the 2013 and 2021 state rates. State-level rates were computed by aggregating opioid and total claims within each state-year and applying the same ratio formula used at the national level, so national and state estimates are directly comparable. The coefficient of variation was computed as the sample standard deviation of the 51 state rates divided by their mean and multiplied by 100, making it a scale-free measure of relative dispersion that can be compared across years with very different national rates. Two-sided statistical significance was set at 0.05. We chose a log-linear specification because the annual rate is bounded below by zero and declined multiplicatively, and we used ordinary least squares on the nine annual observations because the national counts form a complete census rather than a random sample, so the relevant uncertainty is the year-to-year variability captured by the regression residuals rather than sampling error. Analyses were performed in Python 3.14 using pandas for data management, NumPy and SciPy for computation, and statsmodels for the regression models; figures were produced with matplotlib at 300 dots per inch in grayscale.

Sensitivity analyses

We repeated the primary rate analysis under two alternative imputation rules for suppressed opioid counts, substituting the lower bound of the suppression interval (1) and the upper bound (10) for the midpoint. We additionally compared the primary log-linear APC with the simple relative change between 2013 and 2021 to confirm that the trend did not depend on the functional form of the model.

Ethics

The study used public, de-identified, aggregated administrative data with no direct contact with patients; no ethics approval or informed consent was applicable.

RESULTS

Study units and descriptive overview

The analysis included 1,149,905 dentist-year records and 81,539,159 total Part D drug claims across the nine study years. The annual number of dentists increased from 123,033 in 2013 to 129,291 in 2021, and total claims increased from 7,607,079 to 10,529,303 (Table 1).

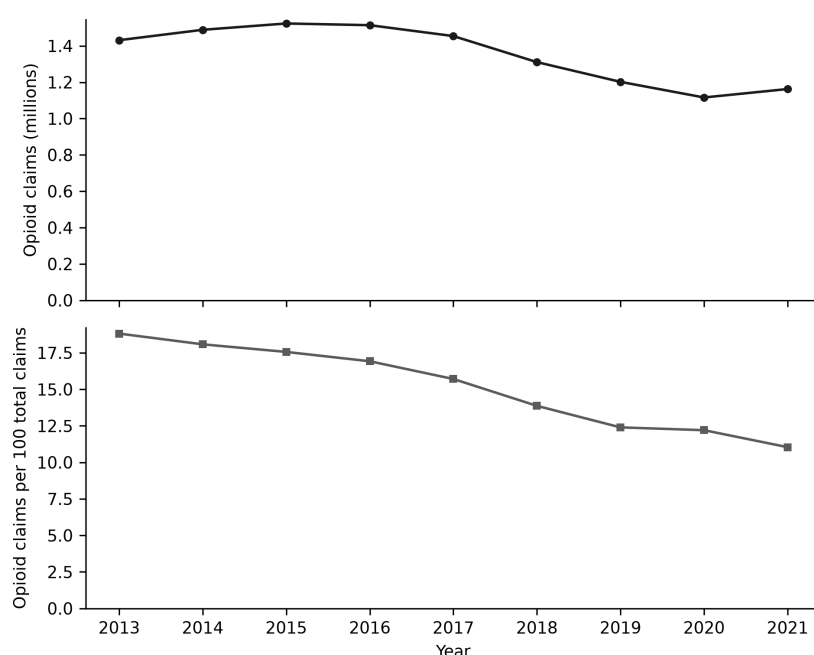
Table 1. National annual opioid prescribing by dentists to Medicare Part D beneficiaries, 2013-2021.

Year	Dentists (n)	Total claims (n)	Opioid claims (n)	Opioid claims per 100 claims	Opioid claims per dentist	Dentists with at least one opioid (%)	Long-acting share of opioid claims (%)
2013	123,033	7,607,079	1,431,237	18.8	11.6	84.1	26.9
2014	126,146	8,232,438	1,488,372	18.1	11.8	82.9	25.8
2015	127,927	8,673,922	1,523,099	17.6	11.9	81.6	24.8
2016	128,399	8,946,389	1,513,690	16.9	11.8	79.9	24.6
2017	129,424	9,256,402	1,453,798	15.7	11.2	77.4	25.3
2018	129,655	9,450,223	1,310,542	13.9	10.1	73.4	27.8
2019	129,929	9,697,589	1,201,868	12.4	9.3	69.1	29.4
2020	126,101	9,145,814	1,115,945	12.2	8.8	67.6	30.3
2021	129,291	10,529,303	1,162,416	11.0	9.0	64.8	28.5

Note: Suppressed opioid counts (1-10 events) imputed at the midpoint 5.5. LA = long-acting. Source: Centers for Medicare and Medicaid Services, Medicare Part D Prescribers by Provider.

National trends (HI)

Opioid claims written by dentists rose slightly from 1,431,237 in 2013 to a peak of 1,523,099 in 2015 and then declined in each subsequent year, reaching 1,162,416 in 2021. Over the full period, the opioid prescribing rate fell from 18.8 to 11.0 opioid claims per 100 total claims, a relative reduction of -41.3% (Figure 1). The annual percent change was -6.8% per year (95% CI -7.92 to -5.61 ; $p < 0.001$). The rate therefore fell because opioids represented a shrinking share of a growing total of dental claims, not because dental prescribing itself contracted. The largest year-to-year change in the rate was -1.8 percentage points, between 2017 and 2018. Opioid claims per dentist decrease from 11.6 to 9.0, an annual percent change of -4.2% per year (95% CI -5.71 to -2.59 ; $p < 0.001$). In sensitivity analyses using the lower and upper suppression bounds, the 2013 rate ranged from 14.7 to 22.9 per 100 claims and the 2021 rate from 8.5 to 13.6, with annual percent changes of -7.3% and -6.4% per year; the direction and magnitude of the decline were insensitive to the imputation rule.

Figure 1. National trend in opioid prescribing by dentists to Medicare Part D beneficiaries, 2013-2021.

Note: Top panel shows opioid claims in millions; bottom panel shows the opioid prescribing rate per 100 total claims (midpoint imputation of suppressed counts). Source: Centers for Medicare and Medicaid Services, Medicare Part D Prescribers by Provider.

Proportion of dentists prescribing opioids (H2)

The proportion of dentists with at least one opioid claim declined from 84.1% in 2013 to 64.8% in 2021, a reduction of –19.3 percentage points (Cochran-Armitage trend $p < 0.001$). The decline was monotonic across the study period, with no year showing an increase in this proportion (Table 1). In absolute terms, the number of dentists who prescribed at least one opioid fell from 103,426 to 83,725 even though the total number of dentists grew over the same period, indicating that the reduction in the proportion was not an artifact of a larger denominator.

Long-acting opioids

Long-acting opioid claims declined from 384,802 in 2013 to 330,762 in 2021. As a proportion of all opioid claims, however, long-acting claims increased from 26.9% to 28.5%, so the fall in long-acting prescribing was proportionally smaller than the fall in short-acting prescribing. The long-acting share declined from 2013 to a minimum in 2016 and then rose in the later years, reaching its highest value in 2020 (Table 1).

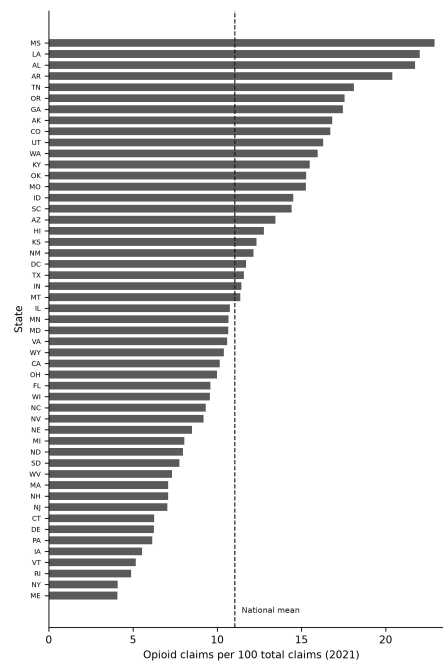
Geographic variation (H3)

In 2021, the state-level opioid prescribing rate ranged from 4.1 per 100 claims in Maine to 22.9 per 100 claims in Mississippi, a maximum-to-minimum ratio of 5.6, with a median of 10.7, an interquartile range of 7.9 to 15.3, and a 10th-to-90th percentile interval of 6.1 to 17.6 (Table 2; Figure 2; Table 3). The five highest states were Mississippi, Louisiana, Alabama, Arkansas, and Tennessee, all in the South; the lowest rates were in Maine, New York, and Rhode Island. Geographic dispersion widened over the study period: the coefficient of variation of state rates increased from 27.8% in 2013 to 41.7% in 2021, and the maximum-to-minimum ratio nearly doubled. State rankings were strongly persistent, with a Spearman rank correlation of 0.88 between the 2013 and 2021 rates ($p < 0.001$) (Figure 3).

Table 2. State-level opioid prescribing rate among dentists by year, 2013-2021.

Year	Median	P25-P75	Minimum (state)	Maximum (state)	Maximum/ minimum ratio	Coefficient of variation (%)
2013	18.8	15.5-23.0	10.1 (NY)	31.5 (MS)	3.1	27.8
2014	17.3	15.0-22.3	8.9 (NY)	31.1 (AK)	3.5	29.1
2015	16.8	14.7-21.8	8.6 (NY)	30.4 (MS)	3.5	29.8
2016	16.3	13.2-21.2	7.4 (NY)	30.0 (MS)	4.1	31.3
2017	15.9	11.0-19.8	6.2 (NY)	28.5 (MS)	4.6	33.4
2018	13.5	9.6-18.1	5.2 (NY)	25.5 (MS)	4.9	36.9
2019	11.9	8.6-17.0	4.6 (NY)	23.7 (MS)	5.2	38.9
2020	11.8	8.7-16.5	4.6 (NY)	23.5 (MS)	5.2	39.4
2021	10.7	7.9-15.3	4.1 (ME)	22.9 (MS)	5.6	41.7

Note: Rate = opioid claims per 100 total claims, imputed at the midpoint of the 1-10 suppression interval. P25-P75 = interquartile range.
Source: Centers for Medicare and Medicaid Services, Medicare Part D Prescribers by Provider.

Figure 2. State-level opioid prescribing rate among dentists, 2021.

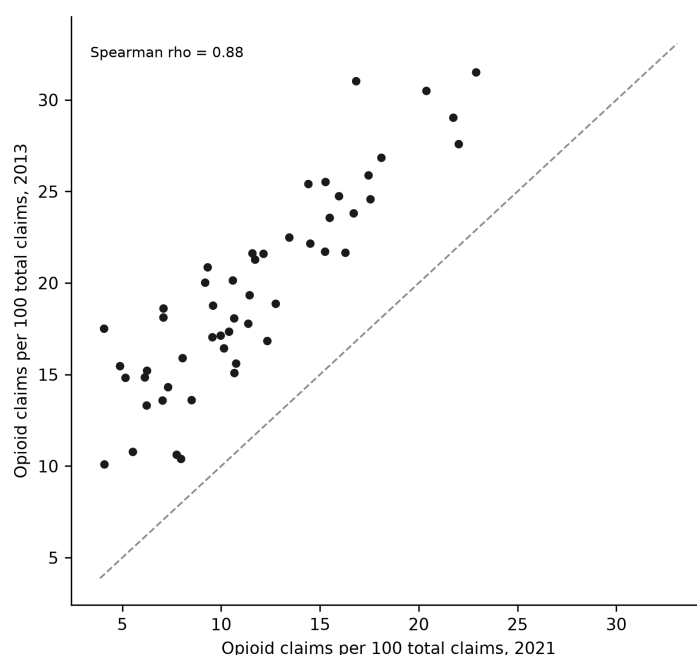
Note: Dashed vertical line indicates the national rate. States are sorted in ascending order of the rate. Source: Centers for Medicare and Medicaid Services, Medicare Part D Prescribers by Provider.

Table 3. State-level opioid prescribing by dentists to Medicare Part D beneficiaries, 2021.

Rank	State	Dentists (n)	Opioid claims per 100 claims	Opioid claims per dentist
1	MS	905	22.9	26.6
2	LA	1,644	22.0	24.3
3	AL	1,557	21.8	28.7
4	AR	907	20.4	21.7
5	TN	2,282	18.1	19.2
6	OR	1,914	17.6	11.6
7	GA	3,272	17.5	16.8

8	AK	305	16.8	7.5
9	CO	2,440	16.7	11.1
10	UT	1,350	16.3	10.9
11	WA	3,169	16.0	9.3
12	KY	1,597	15.5	14.7
13	OK	1,440	15.3	13.3
14	MO	2,168	15.3	13.4
15	ID	760	14.5	10.8
16	SC	1,767	14.4	15.1
17	AZ	2,683	13.5	11.7
18	HI	610	12.8	7.5
19	KS	1,088	12.3	10.0
20	NM	817	12.1	11.8
21	DC	306	11.7	6.5
22	TX	9,790	11.6	8.6
23	IN	2,413	11.4	10.5
24	MT	436	11.4	7.4
25	IL	5,756	10.8	7.7
26	MN	2,202	10.7	6.5
27	MD	2,401	10.7	7.1
28	VA	3,175	10.6	7.2
29	WY	240	10.4	6.6
30	CA	17,090	10.1	6.4
31	OH	4,443	10.0	9.7
32	FL	8,337	9.6	10.6
33	WI	2,301	9.6	6.1
34	NC	3,644	9.3	8.2
35	NV	1,116	9.2	7.9
36	NE	863	8.5	6.5
37	MI	4,601	8.1	7.1
38	ND	272	8.0	4.6
39	SD	290	7.8	6.3
40	WV	611	7.3	7.0
41	MA	3,729	7.1	5.2
42	NH	563	7.1	4.4
43	NJ	4,376	7.0	5.1
44	CT	1,699	6.3	5.1
45	DE	285	6.2	5.3
46	PA	5,200	6.1	5.4
47	IA	1,158	5.5	4.1
48	VT	235	5.2	3.4
49	RI	384	4.9	4.0
50	NY	8,204	4.1	3.7
51	ME	496	4.1	2.7

Note: Rate = opioid claims per 100 total claims, imputed at the midpoint of the 1-10 suppression interval. Source: Centers for Medicare and Medicaid Services, Medicare Part D Prescribers by Provider.

Figure 3. State-level opioid prescribing rate among dentists in 2013 versus 2021.

Note: Dashed line indicates identity. Spearman rho = 0.88. Source: Centers for Medicare and Medicaid Services, Medicare Part D Prescribers by Provider.

Every state recorded a decline in its opioid prescribing rate between 2013 and 2021, although the magnitude differed widely: the reduction ranged from –20.1% in Louisiana to –76.7% in Maine. In 2021, 24 of the 51 states remained above the national rate, and the ten highest states together accounted for 25.3% of all opioid claims written by dentists despite representing a minority of dentists. The geographic picture is therefore one of uniform direction and uneven magnitude: the states that started highest declined least in relative terms.

DISCUSSION

In this national analysis of Medicare Part D dental prescribing, opioid prescribing by dentists declined markedly between 2013 and 2021. The opioid prescribing rate fell by more than one third, the number of opioid claims declined even as total dental claims grew, and the share of dentists who prescribed any opioid decreased. At the same time, state-level prescribing rates remained highly dispersed, their relative ranking changed little over nearly a decade, and dispersion actually increased. All three prespecified hypotheses were supported.

The declining rate is consistent with national studies of dental opioid prescribing in commercial and Medicaid populations, which reported decreases concentrated after 2015.(9-12) Gupta et al.(9) documented a decline in opioid prescribing by dentists from 2010 through 2015, and Yan et al.(10) extended the trend through 2019. Our estimate of 11.0 opioid claims per 100 dental claims in 2021 is lower than the rates reported in those earlier windows, which confirms that the decline continued through the first two years of the COVID-19 pandemic, a period in which dental prescribing shifted in volume and mix.(28) The reduction in opioid claims per dentist indicates a shrinking supply of opioid prescriptions per prescriber rather than a change in the number of dentists, which increased. Earlier Medicaid analyses of opioid prescribing after tooth extraction reported the same direction of change after an earlier period of growth.(29) It is also notable that the opioid rate began to fall from the first study year onward, whereas the absolute number of opioid claims continued to rise until 2015 before declining, a lag that reflects the growth of the underlying dental prescribing population during the early years. The consistency of our Medicare estimates with those from commercial and Medicaid data suggests that the decline was a broad, system-wide shift rather than a payer-specific artifact. The magnitude of the decline is also broadly consistent with earlier estimates. Studies using commercial claims reported reductions in dental opioid prescriptions of a similar order after 2016,(10,11) and analyses of hydrocodone rescheduling found an immediate drop in dental hydrocodone prescribing in late 2014.(13)

One caveat is that our rate is claims-based rather than dose-based: claims do not capture morphine milligram equivalents or days of supply, so a fixed count of claims could conceal changes in the strength or duration of the opioids prescribed. The decline reported here is therefore best interpreted as a reduction in the frequency of opioid prescribing, not necessarily an equivalent reduction in the total opioid dose dispensed by dentists.

The international contrast is instructive. Dentists in the United States prescribed substantially more opioids than dentists in England for comparable care,⁽¹⁷⁾ and the present study shows that even after a prolonged decline, US dental opioid prescribing remained frequent. This gap suggests that further reductions are feasible and that the residual variation across US states is unlikely to be explained by clinical need alone. Comparisons across payers also indicate where the Medicare estimate sits. Dental opioid prescribing rates reported for Medicaid and commercial populations over the same period followed a broadly similar downward trajectory, although direct numeric comparison is complicated by differences in denominators, data years, and the treatment of refills.^(11,12,30) The Medicare figure of 11.0 claims per 100 in 2021 should therefore be read as a payer-specific estimate rather than a universal national rate.

The decline in the proportion of dentists prescribing at least one opioid, from 84.1% to 64.8%, is among the clearest signals that prescribing behavior, not only prescription size, changed. This aligns with repeated evidence that dentists have reduced reliance on opioids in favor of nonsteroidal anti-inflammatory drugs and that educational and policy interventions altered the decision to prescribe at all.^(4,31,32) The relevance of this shift is reinforced by studies of harm: opioids prescribed by dentists have been associated with overdose and other serious opioid-related events, particularly among younger patients who receive them after common procedures such as third molar extraction.^(6,7,33) A lower prevalence of initiating dentists means fewer first exposures, which is the margin that matters most for preventing progression to long-term use. Because this proportion captures the extensive margin of prescribing, it is also the most sensitive single indicator for surveillance and for evaluating whether educational campaigns reach the dentists who still initiate opioid therapy.

Long-acting opioid claims declined in absolute terms but rose slightly as a share of opioid claims, from 26.9% to 28.5%. This differs from the pattern reported for Medicare Part D prescribers overall, where long-acting opioid prescribing fell after the 2016 guideline.⁽¹⁹⁾ The divergence may reflect the composition of dental prescribing, in which long-acting agents form a small but persistent minority used for specific surgical indications; because the dental share rests on imputed suppressed counts, the small change should be interpreted with caution and is better read as the absence of a large reduction in long-acting prescribing than as a true increase.

The geographic findings confirm substantial and persistent state variation. A 5.6-fold difference between the highest and lowest states, a 10th-to-90th percentile span from 6.1 to 17.6 claims per 100, and a coefficient of variation that grew from 27.8% to 41.7% exceed what random variation alone would produce. Marked geographic variation in opioid prescribing is well established for prescribers overall,⁽²¹⁻²³⁾ and state-specific Medicaid analyses also found pronounced differences across jurisdictions.⁽³⁰⁾ Our results show that dentists reproduce and even amplify this pattern within Medicare Part D, with a durable North-to-South gradient in which southern states prescribers write roughly three to five times more opioid claims per 100 than New England and Mid-Atlantic states. The strong rank stability, with a Spearman correlation of 0.88 between 2013 and 2021, indicates that the states that prescribed the most opioids in 2013 continued to do so in 2021, which suggests that the structural, policy, and cultural determinants of prescribing are durable rather than transient. The widening coefficient of variation is also instructive: as the national rate fell, states with already-low rates fell further, so relative dispersion grew even though every state moved in the same direction.

The degree of state variation among dentists is comparable to, and in some respects larger than, the geographic variation documented for prescribers overall. Schieber et al.⁽²¹⁾ reported that state-level opioid prescribing varied severalfold between the highest and lowest states in 2017, and McDonald et al.⁽²²⁾ found substantial regional differences in per-capita opioid supply. Our maximum-to-minimum ratio of 5.6 in 2021 sits at the upper end of these ranges, and unlike the overall pattern, which narrowed in some reports, dispersion among dental prescribers widened. One reason may be that dental prescribing is dominated by a single acute-pain indication, so state variation reflects practice norms and policy more than the differences in patient case mix that characterize chronic-pain prescribing.⁽²³⁾

Several mechanisms plausibly explain both the decline and the variation. The 2014 hydrocodone rescheduling, the 2016 CDC guideline, state prescription duration limits, prescription drug monitoring programs, and dental-specific stewardship all coincided with the observed decline.

(13-16,34) State differences in these policies, in professional norms, and in patient mix likely contribute to the persistent geographic gradient.(35,36) In Medicare specifically, the concentration of prescribing among particular provider types and regions documented in earlier periods may leave residual variation after broad-based declines.(20,37) The pandemic period introduced an additional disruption, with dental service volumes falling sharply in 2020 and recovering in 2021, which complicates attribution of the final years of the trend to policy alone.(28)

The timing of the decline is also informative. The national rate fell most steeply between 2017 and 2018, after both the 2014 hydrocodone rescheduling and the 2016 CDC guideline were already in place, which is consistent with a delayed but durable response to policy rather than an immediate one-time effect.(13,14) This pattern matches the observation that state and federal policies took several years to diffuse into routine dental practice.(15) The pandemic years deserve separate attention as well. The annual number of dentists with any Part D claims fell in 2020 and then recovered in 2021, consistent with the temporary suspension of routine dental care in early 2020, while the opioid rate continued to decline without interruption. Zhang et al.(28) reported that opioid prescribing by US dentists fell in 2020 in association with the COVID-19 outbreak, and our data confirm that the 2020 reduction was part of a longer downward trajectory rather than a pandemic-only aberration. The recovery of total claims in 2021 alongside a still-lower opioid rate suggests that the behavioral change persisted even as service volumes returned.

The residual variation also points to the levers most likely to close the remaining gap. Cluster-randomized evidence from dental practice shows that clinical decision support and de-implementation strategies can reduce opioid prescribing for extractions without worsening pain outcomes.(32) Dental curricula and continuing education have begun to emphasize non-opioid analgesia, and commentators have called for dentistry to end its reliance on opioids.(31) Combined with state-level policy such as prescription duration limits and monitoring programs,(15,16) these professional strategies offer a behavior-oriented route to addressing the southern and western clusters that still prescribe well above the national mean.

For practicing dentists, these results support the view that routine acute dental pain can be managed with non-opioid analgesia in most patients. The large decline in the proportion of dentists who prescribe any opioid suggests that a growing majority of dental providers already treat opioid-free prescribing as the default, which is the standard recommended by current guidance (34) and is consistent with the equivalent or superior efficacy of nonsteroidal anti-inflammatory drugs for acute dental pain.(5) The remaining variation also indicates that some practices and regions have not yet adopted this default, which is where targeted audit, feedback, and peer comparison may be most useful.

The study has several strengths. It used the complete national census of Medicare Part D dental prescribers rather than a sample, covered nine consecutive years including the pandemic years, and combined national trend estimation with a state-level geographic analysis in the same population. The use of a single public data source with consistent variable definitions across years, the prespecified hypothesis-driven analytic plan, and the explicit handling of CMS suppression with sensitivity bounds all support the internal consistency and reproducibility of the estimates. Because the underlying records are a census rather than a survey, the estimates are not subject to sampling error, and the remaining uncertainty attaches chiefly to the suppression imputation and to the ecological interpretation of state-level aggregates.

Several limitations should be considered. First, administrative claims capture dispensing events rather than clinical indication, so the analysis cannot distinguish appropriate from inappropriate prescribing; linkage to diagnosis or procedure data would be needed to judge appropriateness. Second, CMS suppresses counts based on 1 to 10 events, and the midpoint imputation introduces uncertainty in the opioid totals; we bounded this uncertainty with lower and upper imputations and found the trends unchanged, but the level of each estimate depends on the imputation rule. Third, the provider-level file does not distinguish unique beneficiaries across prescribers, so we deliberately avoided per-beneficiary denominators and used per-claim and per-prescriber rates; a beneficiary-level linked file would allow true population rates. Fourth, the design is ecological and cannot establish causal effects of any single policy or guideline, particularly because multiple interventions were implemented simultaneously. Fifth, the Dentist category may include several dental provider types whose prescribing differs, and geographic coding relies on prescriber location rather than patient residence, which can misclassify patients who cross state lines. Sixth, claims-based counts do not measure dose, so reductions in the number of claims do not directly quantify reductions in morphine milligram equivalents or days of supply dispensed; dose-based metrics would complement the counts reported here. Each of these limitations suggests a direction for future work: indication-linked and beneficiary-linked analyses, dose-based metrics, and

multilevel models that adjust for state-level policy and demographic covariates would refine the estimates presented here.

The findings have practical implications. Because a large share of the remaining prescribing is concentrated in a few southern states that changed little over time, geographically targeted interventions, aligned with state policy and dental professional education, may yield disproportionate benefit.^(32,34) The persistent North-to-South gradient also argues for tailoring, rather than assuming, that nationally declining averages apply uniformly to every state. Continued monitoring with public administrative data offers a low-cost mechanism to evaluate whether the observed declines are sustained and whether the geographic gaps narrow in the years ahead. Because the underlying data are updated annually and are freely downloadable, the same analytic pipeline used here can be rerun as new years are released, providing a near-real-time dashboard of dental opioid stewardship in the Medicare population.

CONCLUSIONS

The national opioid prescribing rate of dentists to Medicare Part D beneficiaries declined substantially between 2013 and 2021, driven by reductions in both the volume of opioid claims and the proportion of dentists who prescribed opioids. Long-acting opioid claims also decreased, although their share of opioid claims increased slightly. State-level opioid prescribing varied widely and persistently, with dispersion that widened over the study period and a ranking of states that remained largely stable. These findings quantify the progress of dental opioid stewardship in the Medicare population and identify persistent geographic disparities that remain targets for policy and education. They also provide a national benchmark against which future changes in dental opioid prescribing, and the effects of subsequent policies, can be measured.

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