Opioid Prescribing to US Children and Young Adults in 2019

Kao-Ping Chua, MD, PhD,a Chad M. Brummett, MD,b,c Rena M. Conti, PhD,d Amy S. Bohnert, PhD,b,e

BACKGROUND: Recent national data are lacking on the prevalence, safety, and prescribers of opioid prescriptions dispensed to children and young adults aged 0 to 21 years.

METHODS: We identified opioid prescriptions dispensed to children and young adults in 2019 in the IQVIA Longitudinal Prescription Database, which captures 92% of US pharmacies. We calculated the proportion of all US children and young adults with ≥1 dispensed opioid prescription in 2019. We calculated performance on 6 metrics of high-risk prescribing and the proportion of prescriptions written by each specialty. Of all prescriptions and those classified as high risk by ≥1 metric, we calculated the proportion written by high-volume prescribers with prescription counts at the ≥95th percentile.

RESULTS: Analyses included 4 027 701 prescriptions. In 2019, 3.5% of US children and young adults had ≥1 dispensed opioid prescription. Of prescriptions for opioid-naive patients, 41.8% and 3.8% exceeded a 3-day and 7-day supply, respectively. Of prescriptions for young children, 8.4% and 7.7% were for codeine and tramadol. Of prescriptions for adolescents and young adults, 11.5% had daily dosages of ≥50 morphine milligram equivalents; 4.6% had benzodiazepine overlap. Overall, 45.6% of prescriptions were high risk by ≥1 metric. Dentists and surgeons wrote 61.4% of prescriptions. High-volume prescribers wrote 53.3% of prescriptions and 53.1% of high-risk prescriptions.

CONCLUSIONS: Almost half of pediatric opioid prescriptions are high risk. To reduce high-risk prescribing, initiatives targeting high-volume prescribers may be warranted. However, broad-based initiatives are also needed to address the large share of high-risk prescribing attributable to other prescribers.

WHAT’S KNOWN ON THIS SUBJECT: Recent national data are lacking on the prevalence of dispensed opioid prescriptions among US children and young adults; the frequency of high-risk prescriptions that increase risk of adverse events, including overdose; and the prescribers who account for the most prescriptions.

WHAT THIS STUDY ADDS: Of 4 million opioid prescriptions dispensed to US patients aged 0 to 21 years in 2019, 46% were high risk. Dentists and surgeons wrote 61% of prescriptions. High-volume prescribers with prescription counts at the ≥95th percentile wrote 53% of prescriptions.


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Dr Chua conceptualized and designed the study, collected the data, analyzed and interpreted the data, drafted the initial manuscript, and reviewed and revised the manuscript; Drs Brummett and Conti conceptualized and designed the study, analyzed and interpreted the data, and reviewed and revised the manuscript; Dr Bohnert conceptualized and designed the study, analyzed and interpreted the data, reviewed and revised the manuscript, and provided study supervision, and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Ensuring the safety and appropriateness of pediatric opioid prescribing, defined as prescribing to children aged 0 to 17 years and young adults aged 18 to 21 years, is an important clinical and public health goal. In the short-term, prescription opioid exposure increases the risk of opioid-related adverse events, including overdose.1–6 In the long-term, this exposure is associated with increased lifetime risk of substance use disorders in adolescents and young adults.7–9 Pediatric opioid prescribing also has spillover effects because opioids prescribed to children and young adults can be misused by relatives and friends.10–12 Recent national data are lacking on the prevalence of dispensed opioid prescriptions among US children and young adults, the frequency of high-risk prescriptions that increase the risk of opioid-related adverse events, and the prescribers who account for the most pediatric opioid prescriptions and high-risk prescriptions. In previous studies, researchers have reported recent trends in opioid prescribing to children by using commercial insurance claims and data from individual states,13–15 but the generalizability of findings is unclear. Timely national data on pediatric opioid prescribing could inform the design of initiatives to improve this prescribing. For example, if a small group of prescribers accounts for most high-risk prescribing, initiatives targeting these prescribers may be warranted.

Using a national prescription-dispensing database, we assessed the prevalence, safety, and prescribers of opioid prescriptions dispensed to US children and young adults in 2019. To our knowledge, we provide the most recent and complete data on US pediatric opioid prescribing to date in this study.

**METHODS**

**Data Source**

In January 2021, we conducted a cross-sectional analysis of the 2019 IQVIA Longitudinal Prescription Database. This database contains a record for every prescription dispensed in 2019 from 92% of US retail pharmacies (eg, chain pharmacies and food store pharmacies), 70% of mail-order pharmacies, and 70% of pharmacies in long-term care facilities. In the database, dispensing from pharmacies that serve only patients from specific hospitals or health systems (eg, those affiliated with Kaiser Permanente) is not captured. Data elements include drug name, dosing (eg, days supplied), prescriber identifiers and specialty, patient identifiers and characteristics, and method of payment (commercial, Medicaid or other non-Medicare public insurance [eg, state public insurance programs], cash, and Medicare). Data on patient income, race, ethnicity, and prescription indication are not included. As needed, we used data from 2018 when a 90-day look-back period was required for prescriptions in early 2019.

Analyses assessed dispensing of opioid analgesics and benzodiazepines included in IQVIA’s market definition of these drug classes (Appendix 1). The former excluded opioid cough-and-cold medications and buprenorphine formulations approved for opioid use disorder. Because data were deidentified, the Institutional Review Board of the University of Michigan Medical School exempted this study from review.

**Sample**

Analyses were conducted at the prescription rather than patient level. We included opioid prescriptions dispensed in 2019 to children and young adults aged 0 to 21 years who lived in one of the 50 US states or the District of Columbia. We chose this age range to capture the population seen by pediatric providers.16 We did not include prescriptions from veterinarians. We excluded prescriptions for injectable opioid formulations and prescriptions with missing or potentially invalid dosing information, defined as days supplied ≤0, days supplied >90, or quantity ≤0.

**Prevalence of Dispensed Opioid Prescriptions**

On the basis of dispensing totals and population denominators from the 2019 American Community Survey,17 we calculated the proportion of US children and young adults with ≥1 dispensed opioid prescription in 2019 (see Appendix 2 for details). We repeated analyses by age group, sex, and Census region of patient residence.

**Frequency of High-risk Prescribing**

We calculated performance on 6 metrics of high-risk prescribing:

- Metrics 1 and 2: Proportion of dispensed opioid prescriptions to opioid-naive patients exceeding a 3-day or 7-day supply. The Centers for Disease Control and Prevention opioid prescribing guidelines indicate a 3-day supply usually suffices for acute pain, whereas supplies exceeding 7 days are rarely necessary.10 These thresholds were largely based on data from older adults but may also be reasonable for children and young adults. For example, in previous studies, opioid consumption after common pediatric surgeries was typically ≤3 days.11,19,20 Because data lacked information on indication, we used opioid-naive status as a surrogate for acute pain. In support of this approach, 75.4% of
prescriptions to opioid-naive patients in this study were written by dentists, surgeons, or emergency medicine physicians (Appendix 3). Following a National Quality Forum–endorsed quality measure, we defined opioid-naive status as the absence of dispensed opioid prescriptions in the 90 days before dispensing.

- Metrics 3 and 4: Proportion of opioid prescriptions dispensed to young children aged 0 to 11 years that were for codeine and proportion of these prescriptions that were for tramadol. In 2017, the US Food and Drug Administration contraindicated codeine and tramadol use in young children owing to reports of fatal overdose in this age group.

- Metric 5: Proportion of opioid prescriptions dispensed to adolescents and young adults aged 12 to 21 years with daily dosages of ≥50 morphine milligram equivalents (MMEs). MMEs are a standardized measure of opioid dosage; 50 MMEs corresponds to 10 pills containing 5 mg hydrocodone. We calculated daily MMEs by multiplying strength, quantity, and published MME conversion factors, then dividing by days supplied. The 50-MME threshold derives from the Centers for Disease Control and Prevention guidelines. Although this specific threshold has not been tested in adolescents and young adults, overdose risk in this population increases as daily opioid dosage rises. We did not assess this metric for young children because we lacked information on weight, which affects risks associated with any given dosage level. In contrast, most opioid prescriptions to adolescents and young adults use weight-invariant adult dosing. For example, mean weight of adolescents aged 14 years is ~50 kg.

- Metric 6: Proportion of opioid prescriptions dispensed to adolescents and young adults that overlapped with a benzodiazepine prescription for ≥1 day. We included this metric because concurrent opioid and benzodiazepine exposure greatly increases overdose risk in adolescents and young adults. To calculate the metric, we converted opioid and benzodiazepine prescriptions to periods of exposure that would occur if patients took medications as prescribed. This period began on the dispensing date and ended on the dispensing date plus days supplied minus 1. If the exposure period for an opioid prescription overlapped with that of a benzodiazepine prescription, the opioid prescription was included in the numerator.

We calculated the proportion of all prescriptions classified as high risk by ≥1 metric. For each metric, we calculated performance by demographic characteristics. Using logistic regression with Huber-White robust standard errors clustered at the patient level, we assessed which characteristics were associated with performance. We calculated average marginal effects (AMEs), or the difference in the probability of outcomes if all patients were in a particular demographic category versus the baseline category.

Prescribers of Opioid Prescriptions and High-risk Prescriptions

In prescriber analyses, we excluded prescriptions with missing prescriber identifiers. Of the remaining prescriptions, we calculated the proportion written by each specialty. To assess the degree to which pediatric opioid prescribing and high-risk prescribing is concentrated, we ranked prescribers by the number of opioid prescriptions dispensed to children and young adults in 2019 and identified those with prescription counts at the 95th percentile. We calculated the proportion of all prescriptions and high-risk prescriptions accounted for by these high-volume prescribers versus other prescribers. Among prescriptions from high-volume prescribers and other prescribers that were eligible for each metric of high-risk prescribing, we calculated the proportion classified as high risk by the metric. We compared proportions using χ² tests.

We calculated performance on metrics by specialty and determined which specialties accounted for the most high-risk prescriptions. We present results in Appendix 4 for interested readers but do not discuss them owing to limited space.

Statistical Analysis

Analyses used SAS 9.4 (SAS Institute, Cary, NC), Stata 15.1 (Stata Corp, College Station, TX), and 2-sided hypothesis tests with α = .05.

RESULTS

Sample

The database included 144 734 094 opioid prescriptions dispensed in 2019; 4 030 834 (2.8%) were for patients aged 0 to 21 years. Of these prescriptions, 3 133 (0.08%) were excluded. Of the remaining 4 027 701 prescriptions in the sample, 3 487 263 (86.6%) were for adolescents and young adults and 3 250 443 (80.7%) were for opioid-naive patients. Method of payment was commercial insurance for 2 447 863 (60.8%) prescriptions, followed by Medicaid and/or other public insurance (1 106 206; 27.5%), cash (330 225; 8.2%), and Medicare (143 407; 3.6%). Hydrocodone accounted for 2 120 784 (52.7%) prescriptions, followed by oxycodone (857 641; 21.3%), codeine (556 463; 13.8%), and tramadol (395 829; 9.8%); 51 046 (1.3%) prescriptions were for...
extended-release and/or long-acting opioids. Median days supplied was 3 days (25th–75th percentile: 3–5).

The 4,027,701 prescriptions were for 3,131,759 patients; 449,310 (14.3%) patients had multiple dispensed prescriptions in 2019.

Prevalence of Dispensed Opioid Prescriptions

In Table 1, we display prevalence estimates overall and by demographic subgroup. Of all US children and young adults, 3.5% had ≥1 dispensed opioid prescription in 2019. For young children aged 0 to 11 years and adolescents and young adults aged 12 to 21 years, this proportion was 0.9% and 6.3%, respectively. The proportion of children and young adults with ≥1 dispensed opioid prescription in 2019 was highest in the south (4.1%).

TABLE 1 Prevalence of Dispensed Opioid Prescriptions Among US Children and Young Adults Aged 0 to 21 Years in 2019

<table>
<thead>
<tr>
<th>No. Prescriptions (Percentage of Total)</th>
<th>No. Patients in the Database With ≥1 Dispensed Opioid Prescription in 2019</th>
<th>US Population Denominator From 2019 ACS*</th>
<th>Rate of Dispensed Opioid Prescriptions per 100 US Children and Young Adults</th>
<th>Proportion Of US Children and Young Adults With ≥1 Dispensed Opioid Prescription in 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall 4,027,701 (100.0)</td>
<td>3,131,759</td>
<td>90,657,309</td>
<td>4.4</td>
<td>3.5</td>
</tr>
<tr>
<td>Age group, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–11 540,438 (13.4)</td>
<td>427,241</td>
<td>47,552,304</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>12–21 3,487,263 (86.6)</td>
<td>2,704,518</td>
<td>43,105,005</td>
<td>8.1</td>
<td>6.3</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male 1,818,708 (45.2)</td>
<td>1,430,441</td>
<td>48,439,447</td>
<td>3.9</td>
<td>3.1</td>
</tr>
<tr>
<td>Female 2,203,232 (54.7)</td>
<td>1,896,980</td>
<td>44,217,862</td>
<td>5.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Unknown 576 (0.1)</td>
<td>433</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Census region</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast 452,473 (11.2)</td>
<td>384,380</td>
<td>14,426,616</td>
<td>3.1</td>
<td>2.5</td>
</tr>
<tr>
<td>Midwest 854,430 (21.0)</td>
<td>663,939</td>
<td>19,050,769</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>South 1,906,296 (47.3)</td>
<td>1,448,345</td>
<td>33,550,699</td>
<td>5.4</td>
<td>4.1</td>
</tr>
<tr>
<td>West 824,502 (20.5)</td>
<td>680,989</td>
<td>21,829,255</td>
<td>3.8</td>
<td>3.0</td>
</tr>
</tbody>
</table>

N/A, not applicable; ACS, American Community Survey.

*See Appendix 2 for details on obtaining population denominators.

b Population denominators for patients of unknown sex could not be calculated. Prevalence estimates for male and female patients would be slightly higher if patient sex were known for these 5,761 prescriptions.

Prevalence of Dispensed Opioid Prescriptions

In Table 1, we display prevalence estimates overall and by demographic subgroup. Of all US children and young adults, 3.5% had ≥1 dispensed opioid prescription in 2019. For young

TABLE 2 Performance on 2 Metrics Assessing Days Supplied in Opioid Prescriptions for Opioid-Naive Children and Young Adults

<table>
<thead>
<tr>
<th>No. Prescriptions Eligible for Metric</th>
<th>No. Prescriptions in Numerator (%)</th>
<th>No. Prescriptions Eligible for Metric</th>
<th>No. Prescriptions in Numerator (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall 3,250,443</td>
<td>1,359,082 (41.8)</td>
<td>3,250,443</td>
<td>124,874 (3.8)</td>
</tr>
<tr>
<td>Age group, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–11 437,914</td>
<td>234,551 (53.6)</td>
<td>437,914</td>
<td>40,770 (9.3)</td>
</tr>
<tr>
<td>12–21 2,812,529</td>
<td>1,124,531 (40.0)</td>
<td>2,812,529</td>
<td>84,104 (3.0)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male 1,478,677</td>
<td>619,285 (41.9)</td>
<td>1,478,677</td>
<td>60,185 (4.1)</td>
</tr>
<tr>
<td>Female 1,767,313</td>
<td>737,723 (41.7)</td>
<td>1,767,313</td>
<td>64,127 (3.6)</td>
</tr>
<tr>
<td>Unknown 4,453</td>
<td>2,064 (46.4)</td>
<td>4,453</td>
<td>554 (12.4)</td>
</tr>
<tr>
<td>Census region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast 374,372</td>
<td>121,781 (32.5)</td>
<td>374,372</td>
<td>9648 (2.6)</td>
</tr>
<tr>
<td>Midwest 687,665</td>
<td>283,918 (41.3)</td>
<td>687,665</td>
<td>23,110 (3.4)</td>
</tr>
<tr>
<td>South 1,504,480</td>
<td>656,505 (43.6)</td>
<td>1,504,480</td>
<td>64,119 (4.3)</td>
</tr>
<tr>
<td>West 683,926</td>
<td>296,878 (43.4)</td>
<td>683,926</td>
<td>27,987 (4.1)</td>
</tr>
<tr>
<td>Method of payment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial 2,034,441</td>
<td>797,592 (39.2)</td>
<td>2,034,441</td>
<td>66,649 (3.3)</td>
</tr>
<tr>
<td>Medicaid or other public insurance</td>
<td>912,743</td>
<td>412,178 (45.2)</td>
<td>912,743</td>
</tr>
<tr>
<td>Cash 271,669</td>
<td>129,039 (47.5)</td>
<td>271,669</td>
<td>25,834 (9.5)</td>
</tr>
<tr>
<td>Medicareb 31,590</td>
<td>20,273 (64.2)</td>
<td>31,590</td>
<td>6094 (19.3)</td>
</tr>
</tbody>
</table>

Opioid-naive patients were those without any dispensed opioid prescriptions during the 90 days to 1 day before the dispensing date of the index prescription.

* By definition, all prescriptions for opioid-naive patients with days supplied >7 days were included among prescriptions for opioid-naive patients with days supplied >3 days.

b Medicare covers children and young adults with end-stage renal disease and some children and young adults with disabilities.
<table>
<thead>
<tr>
<th>Age group, y</th>
<th>No. Prescriptions Eligible for Metric</th>
<th>No. Prescriptions in Numerator (%)</th>
<th>No. Prescriptions Eligible for Metric</th>
<th>No. Prescriptions in Numerator (%)</th>
<th>No. Prescriptions Eligible for Metric</th>
<th>No. Prescriptions in Numerator (%)</th>
<th>No. Prescriptions Eligible for Metric</th>
<th>No. Prescriptions in Numerator (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–11</td>
<td>540 438</td>
<td>45 494 (8.4)</td>
<td>540 438</td>
<td>41 619 (7.7)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>12–21</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>3 487 263</td>
<td>402 450 (11.5)</td>
<td>3 487 263</td>
<td>159 269 (4.6)</td>
</tr>
<tr>
<td>Sex</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Male</td>
<td>298 003</td>
<td>24 340 (8.2)</td>
<td>298 003</td>
<td>21 146 (7.1)</td>
<td>1 520 705</td>
<td>187 403 (12.3)</td>
<td>1 520 705</td>
<td>65 001 (4.3)</td>
</tr>
<tr>
<td>Female</td>
<td>241 208</td>
<td>21 031 (8.7)</td>
<td>241 208</td>
<td>19 953 (8.3)</td>
<td>1 962 024</td>
<td>214 468 (10.9)</td>
<td>1 962 024</td>
<td>94 075 (4.8)</td>
</tr>
<tr>
<td>Unknown</td>
<td>1227</td>
<td>123 (10.0)</td>
<td>1227</td>
<td>520 (42.4)</td>
<td>4534</td>
<td>553 (12.3)</td>
<td>4534</td>
<td>193 (4.3)</td>
</tr>
<tr>
<td>Census region</td>
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</tr>
<tr>
<td>Northeast</td>
<td>44 250</td>
<td>30 12 (6.8)</td>
<td>44 250</td>
<td>3744 (8.5)</td>
<td>408 223</td>
<td>48 281 (11.8)</td>
<td>408 223</td>
<td>19 858 (4.9)</td>
</tr>
<tr>
<td>Midwest</td>
<td>115 571</td>
<td>74 77 (6.5)</td>
<td>115 571</td>
<td>8703 (7.5)</td>
<td>729 859</td>
<td>81 814 (11.2)</td>
<td>729 859</td>
<td>27 899 (3.8)</td>
</tr>
<tr>
<td>South</td>
<td>286 889</td>
<td>28 354 (9.9)</td>
<td>286 889</td>
<td>25 672 (8.5)</td>
<td>1 618 397</td>
<td>184 779 (11.4)</td>
<td>1 618 397</td>
<td>80 567 (5.0)</td>
</tr>
<tr>
<td>West</td>
<td>93 718</td>
<td>66 16 (7.1)</td>
<td>93 718</td>
<td>55 00 (5.9)</td>
<td>730 784</td>
<td>97 556 (12.0)</td>
<td>730 784</td>
<td>31 145 (4.3)</td>
</tr>
<tr>
<td>Method of payment</td>
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<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>268 783</td>
<td>22 721 (8.5)</td>
<td>268 783</td>
<td>22 774 (8.5)</td>
<td>2 179 080</td>
<td>287 919 (12.3)</td>
<td>2 179 080</td>
<td>93 839 (4.3)</td>
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<td>Medicaid or other public insurance</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash</td>
<td>55 311</td>
<td>11 320 (20.5)</td>
<td>55 311</td>
<td>8986 (16.2)</td>
<td>274 914</td>
<td>29 402 (10.7)</td>
<td>274 914</td>
<td>10 504 (3.8)</td>
</tr>
<tr>
<td>Medicare</td>
<td>32 151</td>
<td>20 01 (6.8)</td>
<td>32 151</td>
<td>7555 (23.5)</td>
<td>111 256</td>
<td>25 729 (23.1)</td>
<td>111 256</td>
<td>24 611 (22.1)</td>
</tr>
</tbody>
</table>

Young children were those aged 0 to 11 years; AYAs were those aged 12 to 21 years. AYA, adolescent and young adult; N/A, not applicable.
**Frequency of High-risk Prescribing**

In Tables 2–3, we display performance on the 6 metrics of high-risk prescribing. Among 3,250,443 prescriptions for opioid-naive patients, 1,359,082 (41.8%) and 124,874 (3.8%) exceeded a 3-day and 7-day supply, respectively (Fig 1). Among 540,438 prescriptions for young children, 45,494 (8.4%) and 41,619 (7.7%) were for codeine and tramadol, respectively. Among 3,487,263 prescriptions for adolescents and young adults, 402,430 (11.5%) had a daily MME of ≥50 and 159,269 (4.6%) had benzodiazepine overlap. Among all 4,027,701 prescriptions, 1,834,776 (45.6%) were classified as high risk by ≥1 metric.

For each metric, the AMEs of demographic characteristics on performance are displayed in Appendix 5. Prescriptions for opioid-naive patients were less likely to exceed a 3-day supply if they were for adolescents and young adults rather than young children (unadjusted difference: −13.6 percentage points; AME: −12.2; 95% confidence interval [CI]: −12.4 to −12.1). The same pattern occurred for prescriptions exceeding a 7-day supply. Prescriptions to young children were less likely to be for codeine if the method of payment was Medicaid and/or other public insurance rather than commercial insurance (unadjusted difference: −3.4 percentage points; AME: −3.6; 95% CI: −3.7 to −3.4). The same pattern occurred for tramadol. For metrics assessing prescriptions to adolescents and young adults with a daily MME of ≥50 and opioid-benzodiazepine overlap, performance differences between demographic subgroups were generally modest.

**Prescribers of Opioid Prescriptions and High-risk Prescriptions**

Of 4,027,701 prescriptions in the sample, 84,470 (2.1%) were excluded in prescriber analyses owing to missing prescriber identifiers. Of the remaining 3,943,231 prescriptions, dentists accounted for 1,504,370 (38.2%) and surgeons accounted for 918,154 (23.3%). These prescribers collectively accounted for 2,422,524 prescriptions (61.4%) (Table 4). Surgical subspecialties accounting for the most prescriptions were orthopedics (7.6% of the 3,943,231 prescriptions) and otolaryngology (6.3%) (Appendix 6). Surgeons (47.1%) accounted for a higher proportion of prescriptions for opioid-naive patients in 2019.

![Distribution of days supplied among dispensed opioid prescriptions for opioid-naive children and young adults. A total of 3,250,443 opioid prescriptions were dispensed to such patients in 2019. Of these, 1,234,208 (38.0%) had days supplied between 4 and 7 days. Additionally, 250,8 had days supplied exceeding 30 days; these prescriptions are not depicted in this graph owing to their small numbers.](image-url)
TABLE 4 Opioid Prescriptions Dispensed to Children and Young Adults In 2019, by Prescriber Specialty

<table>
<thead>
<tr>
<th>Specialty</th>
<th>No. Prescriptions</th>
<th>Percentage of All Prescriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dentist*</td>
<td>1 504 370</td>
<td>38.2</td>
</tr>
<tr>
<td>Surgery†</td>
<td>918 154</td>
<td>23.3</td>
</tr>
<tr>
<td>Physician assistant</td>
<td>282 194</td>
<td>7.2</td>
</tr>
<tr>
<td>Emergency medicine‡</td>
<td>279 478</td>
<td>7.1</td>
</tr>
<tr>
<td>Nurse practitioner</td>
<td>218 143</td>
<td>5.5</td>
</tr>
<tr>
<td>Family medicine§</td>
<td>194 316</td>
<td>4.9</td>
</tr>
<tr>
<td>Obstetrics and/or gynecology¶</td>
<td>138 888</td>
<td>3.5</td>
</tr>
<tr>
<td>Internal medicine¶</td>
<td>85 539</td>
<td>2.2</td>
</tr>
<tr>
<td>General pediatrics</td>
<td>66 376</td>
<td>1.7</td>
</tr>
<tr>
<td>Podiatry</td>
<td>59 630</td>
<td>1.5</td>
</tr>
<tr>
<td>Pain medicine and anesthesiology‖</td>
<td>43 359</td>
<td>1.1</td>
</tr>
<tr>
<td>Hematology and/or oncology‖</td>
<td>37 655</td>
<td>1.0</td>
</tr>
<tr>
<td>Physical medicine and rehabilitation§</td>
<td>21 059</td>
<td>0.5</td>
</tr>
<tr>
<td>Hospice and/or palliative care</td>
<td>2599</td>
<td>0.1</td>
</tr>
<tr>
<td>All other prescribers‖</td>
<td>81 434</td>
<td>2.1</td>
</tr>
<tr>
<td>Unknown</td>
<td>9836</td>
<td>0.2</td>
</tr>
<tr>
<td>Total§</td>
<td>3 943 231</td>
<td>100.0</td>
</tr>
</tbody>
</table>

* Includes general dentists, dental subspecialists (anesthesiology, endodontics, orthodontics, pedodontists, periodontics, and orthodontics), and oral and maxillofacial surgeons.
† Includes cardiothoracic, colorectal, general, hand, neurosurgery, ophthalmology, orthopedic surgery, otolaryngology, pediatric, plastic, thoracic, transplant, urology, and vascular surgery.
‡ Includes pediatric emergency medicine physicians and emergency medicine physicians in clinical informatics, medical toxicology, sports medicine, and undersea medicine.
§ Includes family medicine physicians in clinical informatics, geriatric medicine, and sports medicine and those dually boarded in family medicine and/or psychiatry.
¶ Includes general obstetrics and/or gynecology, gynecologic oncology, maternal and fetal medicine, reproductive endocrinology and infertility, and female pelvic medicine and/or reconstructive surgery.
‖ Includes internists in sports medicine and geriatrics and physicians dually boarded in internal medicine and anesthesiology, family medicine, pediatrics, and preventive medicine.
‖ Includes nonpain medicine anesthesiology and pain medicine physicians from anesthesiology, neurology, physical medicine and/or rehabilitation, and psychiatry.
‖ Includes pediatric and nonpediatric hematology and/or oncology.
‖ Includes pediatric and nonpediatric physical medicine and rehabilitation. Physical medicine and rehabilitation physicians in pain medicine were classified as pain medicine physicians.
§ Addition, aerospace, allergy and/or immunology, anesthesiology, cardiology, chiropractic, critical care, dermatology, endocrinology, gastroenterology, general practice, genetics, gastroenterology and/or hepatology, hospitalists, hygiene, infectious disease, legal medicine, microbiology, midwife, military, naturopath, neonatology, nephrology, neurology, neuromuscular medicine, nuclear medicine, nurse, nurse anesthetist, occupational medicine, optometrist, osteopathy, pathologist, pharmaceutical medicine, pharmacist, preventive medicine, psychiatry, pulmonology, radiation oncology, radiology, rheumatology, sleep medicine, and toxicology. Also includes pediatricians in the following specialties: adolescent medicine, child abuse, clinical informatics, developmental and/or behavioral, neurodevelopmental, and medical toxicology, sports medicine. These pediatricians accounted for just 673 pediatric opioid prescriptions.
‖ Sample for this analysis includes 3 943 231 prescriptions with nonmissing prescriber identifiers.
‖ Values in the rows above do not add to 100% owing to rounding error.

For each metric, we display the proportion of eligible prescriptions from high-volume prescribers and other prescribers that were classified as high-risk in Figure 3. This proportion was consistently higher among prescriptions from other prescribers (median difference: 2.9 percentage points; P < .001 for all differences).

DISCUSSION

In 2019, almost half of the 4 million opioid prescriptions dispensed to US children and young adults were classified as high risk by at least 1 of 6 metrics. Dentists and surgeons collectively accounted for 6 in 10 prescriptions. Approximately 20 000 high-volume prescribers (those with prescription counts at the ≥95th percentile) accounted for 53% of all prescriptions and high-risk prescriptions.

In this study, we provide national data on the prevalence and demographic correlates of high-risk pediatric opioid prescribing. In 2019, 41.8% and 3.8% of opioid prescriptions dispensed to opioid-naive children and young adults exceeded a 3-day and 7-day supply, respectively, although many of these prescriptions likely were for dental and surgical procedures that do not require long durations of opioid therapy. Investigators have substantially reduced opioid quantities in perioperative prescriptions for adult patients by developing procedure-specific prescribing guidelines on the basis of data on patient-reported postoperative opioid consumption. Similar efforts have begun in some pediatric institutions but should be more

young children than dentists (11.8%). In contrast, dentists (42.1%) accounted for a higher proportion of prescriptions for adolescents and young adults than surgeons (19.7%) (Appendix 7). General pediatricians accounted for 1.7% of the 3 943 231 prescriptions.

The 3 943 231 prescriptions were written by 404 102 prescribers. The median prescriber accounted for 3 prescriptions (25th–75th percentiles: 1–7). The 95th percentile was 31. Among 20,848 (5.2%) high-volume prescribers with prescription counts of ≥31, 7431 (35.6%) and 6684 (32.1%) were dentists and surgeons; 10,579 (50.7%) practiced in the south. Of the other 383,254 prescribers, 56,371 (14.7%) and 64,997 (17.0%) were dentists and surgeons; 154,852 (40.4%) practiced in the south. High-volume prescribers accounted for 210,283 prescriptions (53.3% of 3 943 231 prescriptions) and 950,137 high-risk prescriptions (53.1% of 1,787,721 high-risk prescriptions). Other prescribers accounted for 46.7% and 46.9% of prescriptions and high-risk prescriptions (Figure 2). In Appendix 8, we report results when defining high-volume prescribers as those with prescription counts at the ≥99th percentile.

In this study, we provide national data on the prevalence and demographic correlates of high-risk pediatric opioid prescribing. In 2019, 41.8% and 3.8% of opioid prescriptions dispensed to opioid-naive children and young adults exceeded a 3-day and 7-day supply, respectively, although many of these prescriptions likely were for dental and surgical procedures that do not require long durations of opioid therapy. Investigators have substantially reduced opioid quantities in perioperative prescriptions for adult patients by developing procedure-specific prescribing guidelines on the basis of data on patient-reported postoperative opioid consumption. Similar efforts have begun in some pediatric institutions but should be more
widespread. Our findings highlight the importance of including young children in such efforts. In 2019, prescriptions for opioid-naive patients were more likely to exceed a 3-day supply if they were for young children rather than for adolescents and young adults, potentially because the latter were more likely to receive dental opioid prescriptions, which are typically of short duration.31

Approximately 1 in 6 opioid prescriptions dispensed to young children were for codeine or tramadol, both contraindicated in this age group.22 The persistent use of codeine is consistent with a study revealing incomplete reductions in codeine prescribing to children undergoing tonsillectomy after a 2013 Food and Drug Administration contraindication.32,33 To reduce codeine and tramadol prescribing to young children, electronic health record systems and pharmacists could prompt clinicians to consider alternatives when this prescribing is attempted. Additionally, insurers could refuse to cover codeine or tramadol prescriptions for young children.

Among opioid prescriptions dispensed to adolescents and young adults, 11.5% had daily opioid dosages of $\geq 50$ MMEs. In the rare instances in which such elevated dosages are required for children and young adults (eg, cancer pain), interventions to mitigate overdose risk should be considered, such as coprescribing naloxone.34 Moreover, 4.6% of opioid prescriptions dispensed to adolescents and young adults overlapped with a benzodiazepine prescription. In this population, benzodiazepines have limited evidence of efficacy for anxiety, the most common indication for these medications.35 Reducing low-value benzodiazepine prescribing may therefore be a feasible method to reduce concurrent opioid and benzodiazepine exposure.

The outsized role of dentists and surgeons in pediatric opioid prescribing suggests that reductions in prescribing by these clinicians could substantially lower prescription opioid exposure in children and young adults. Evidence suggests such reductions could be achieved without compromising pain control. For example, almost 80% of dental opioid prescriptions for adolescents and young adults are for tooth extraction,31 a procedure for which ibuprofen provides effective analgesia.36 As another example, randomized trials suggest opioids and ibuprofen provide
equivalent analgesia for tonsillectomy, a common pediatric surgery.\textsuperscript{37,38} Despite this, researchers reported that 6 in 10 privately insured children undergoing tonsillectomy from 2016 to 2017 had dispensed perioperative opioid prescriptions.\textsuperscript{39} Avoiding opioid prescribing for surgical and dental procedures not only decreases the risk of misuse and overdose but also decreases the risk of side effects, such as vomiting and constipation.\textsuperscript{40} Consequently, when nonopioids provide effective analgesia, first-line use of these medications could improve safety and patient experience.

Approximately 20,000 high-volume prescribers accounted for 53\% of pediatric opioid prescriptions. The concentrated nature of pediatric opioid prescribing is consistent with a previous study of opioid prescribing to privately insured Americans, most of whom were adults.\textsuperscript{41} Notably, high-volume prescribers may not necessarily have high rates of opioid prescribing. For example, surgeons whose patient volume is higher than average may be high-volume prescribers even if their prescribing rates are similar to other surgeons. Nonetheless, the outsized role of high-volume prescribers in pediatric opioid prescribing suggests that their prescribing rates may warrant particular attention.

High-volume prescribers also accounted for 53\% of high-risk prescriptions. This finding suggests that initiatives to improve the safety of pediatric opioid prescribing may be most efficient if they target high-volume prescribers. Importantly, however, other prescribers collectively accounted for 47\% of high-risk prescriptions and had slightly worse performance on metrics of high-risk prescribing compared with high-volume prescribers. Consequently, broad-based initiatives inclusive of all prescribers should also be considered.

We estimate that 6.3\% of US adolescents and young adults had dispensed opioid prescriptions in

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure3.png}
\caption{Percent of eligible opioid prescriptions from high-volume prescribers and other prescribers that were classified as high-risk by 6 metrics. High-volume prescribers were the 20,848 prescribers with prescription counts at the 95th percentile or above among all clinicians who accounted for $\geqslant 1$ dispensed opioid prescription to children and young adults in 2019. Other prescribers were the 383,254 prescribers with prescriptions below the 95th percentile. Data source: 2019 IQVIA Longitudinal Prescription Database. AYA, adolescent and young adult; MME, morphine milligram equivalents.}
\end{figure}
2019. This estimate is markedly lower than the prevalence of past-year opioid use reported by adolescents and young adults participating in the National Survey on Drug Use and Health (NSDUH). In the 2015–2016 NSDUH, 17.2% and 24.4% of respondents aged 12 to 17 years and 18 to 25 years, respectively, reported past-year use of opioids prescribed to them but not past-year misuse of their opioids or of opioids prescribed to others. A caveat is that US opioid prescribing has declined since 2015, partly owing to heightened awareness of the opioid epidemic. Moreover, past-year opioid use could include use of leftover opioids from prescriptions written more than a year ago. Additional research is needed to reconcile our estimates with the NSDUH.

Study strengths include our use of timely national data. However, limitations exist. First, analyses underestimate the prevalence of dispensed opioid prescriptions among US children and young adults because data do not include all pharmacies. Second, dispensing from hospital-specific pharmacies was not observed. Some hospitals with such pharmacies may be affiliated with academic medical centers, which may have prescribing practices that differ from other settings. Third, the role of surgical care in pediatric opioid prescribing is underestimated in our analyses because physician assistants and nurse practitioners account for one-fifth of perioperative opioid prescriptions. Fourth, because data lacked clinical details, the denominator for estimates of the prevalence of dispensed opioid prescriptions could not be restricted to patients with potential indications for opioids (eg, injuries). Finally, the outbreak of coronavirus disease 2019 delayed many dental and surgical procedures, the primary indications for pediatric opioid prescribing. Consequently, the rate of this prescribing during the pandemic is likely lower than in 2019. However, findings will still inform quality improvement initiatives, unless the pandemic permanently alters practice.

CONCLUSIONS
Reducing opioid prescribing by dentists and surgeons could substantially lower prescription opioid exposure in children and young adults. To improve the safety of pediatric opioid prescribing, initiatives targeting high-volume prescribers may be warranted. However, broad-based initiatives are also needed to address the large share of high-risk prescribing attributable to other prescribers.

ABBREVIATIONS
ame: average marginal effect CI: confidence interval MME: morphine milligram equivalent NSDUH: National Survey on Drug Use and Health

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prescription opioids to heroin among US adolescents followed into adulthood.  


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