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## DATAWATCH

# Children And The Opioid Epidemic: Age-Stratified Exposures And Harms

Using North Carolina Medicaid 2016–18 claims data, we found that approximately one in ten adolescents (10.8 percent) filled at least one opioid prescription per year. Dentists, advanced practice providers, and surgeons were common prescribers of opioids to children. In addition, half of children who experienced opioid-related adverse events had filled opioid prescriptions in the prior six months.

**A**mong adult patients admitted for opioid use disorder treatment, one-third report having their first opioid exposure in childhood, highlighting the importance of addressing early opioid exposures.<sup>1,2</sup> Children's opioid-related hospitalizations and deaths have doubled or tripled in recent decades.<sup>3,4</sup> Opioid exposures in childhood are responsible for the majority of drug-related pediatric fatalities and are potentially linked to opioid misuse in adulthood.<sup>1,5</sup>

Up to 15 percent of children have at least one opioid prescription fill each year, and prescrip-

tions to children have been linked to subsequent opioid-related adverse events.<sup>6</sup> Disparities in pediatric opioid exposures and opioid-related harms have been reported by age, race, urban/rural status, and medical complexity.<sup>3,6–9</sup>

In this study we characterized age-stratified opioid exposures, opioid-related harms, and disparities for North Carolina Medicaid-insured children. As shown in exhibit 1, we found that the yearly prevalence of exposures and harms among children was highest among older adolescents, with one in ten (10.8 percent) adolescents ages 15–17 having at least one opioid prescription fill per year and nearly 280 of every

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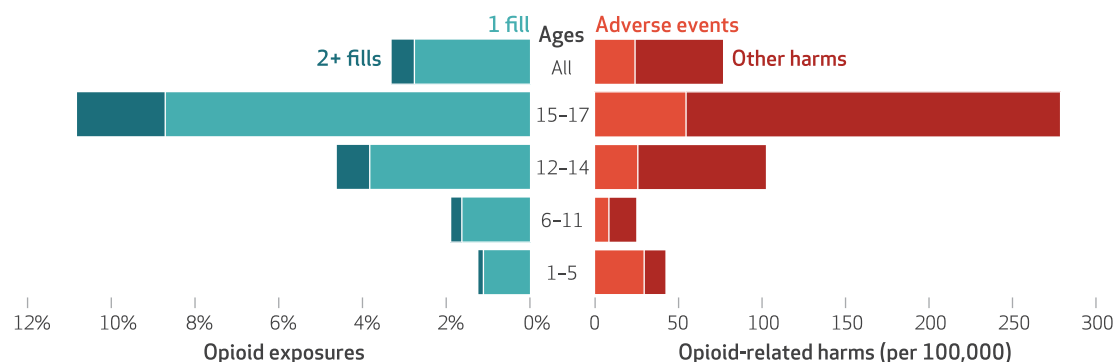
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## EXHIBIT 1

Yearly prevalence of opioid exposures and opioid-related harms among Medicaid-insured children in North Carolina, 2016–18



**SOURCE** Authors' analysis of North Carolina Medicaid prescription claims, enrollment, inpatient and outpatient encounter, and provider files for 3,242,196 beneficiaries ages 1–17 enrolled at any point during the period 2016–18. **NOTES** Data from 2016–18 are combined. Yearly prevalence of opioid exposures is presented as percentage; yearly prevalence of harms is presented as rates per 100,000 children. "1 fill" and "2+ fills" are opioid prescription fills per year. Significant differences between age groups were identified for one fill, two or more fills, any fill, opioid-related adverse events (that is, "poisonings by, adverse effects of, or underdosing of opium"), and other opioid-related harms (that is, "opioid abuse," "opioid dependence," or "opioid use, unspecified";  $p < 0.001$ ) using chi-square tests.

100,000 children of that age experiencing one or more opioid-related harms each year.

### Study Data And Methods

We conducted a cross-sectional analysis of 2016–18 North Carolina Medicaid enrollment and medical/pharmacy claims data. Children ages 1–17 enrolled during the study period were included.

Outpatient opioid prescription fills (exposures) were identified in pharmacy claims data, using National Drug Codes for opioid type and National Provider Identification codes for prescriber type, categorized as physicians by specialty or as dentists or advanced practice providers, which includes nurse practitioners and physician assistants. See the online appendix for prescriber categories.<sup>10</sup>

Opioid-related harms were identified from inpatient and outpatient medical claims using *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision (ICD-10), codes and were classified as opioid-related adverse events (for example, T40.OX, “poisoning by, adverse effect of and underdosing of opium”) or other opioid-related harms (F11.X, “opioid abuse,” “opioid dependence,” or “opioid use, unspecified”), as shown in appendix exhibit A1.<sup>10</sup> We included “opioid use, unspecified” under the harms category because most “opioid use, unspecified” subcategories include descriptors of harms (for example, “opioid use, unspecified with intoxication”). Also, documentation of an opioid use diagnosis, although potentially nonspecific, is likely associated with increased risk for opioid-related harm (that is, risk for poisonings or withdrawal) even if opioids are indicated. Enrollment data were used to characterize child age, sex, race, and urban-rural status. Chronic disease status was defined according to complex chronic conditions methodology among children with six months of continuous enrollment.<sup>9</sup>

The prevalence of opioid exposures and harms for children ages 1–17 was calculated using mid-year enrollment as the denominator, presented for 2016–18. For index harms (that is, a harm not preceded by another harm within the previous six months) in children ages 6–17, the most recent opioid prescription fill was identified in the six months before diagnosis; results for children ages 1–5 were not reported because of small sample sizes. The sociodemographic and clinical characteristics of children with opioid exposures and harms were compared using chi-square tests.

This study had several limitations. First, Medicaid pharmacy claims for filled opioid prescrip-

tions likely underestimate children's opioid exposures because they do not capture other sources of exposure such as illicit opioids and household members' prescriptions.<sup>11</sup> Second, claims data also lack the clinical information necessary to assess prescription appropriateness or validate the inclusion of diagnoses captured. The inclusion of more ambiguous ICD-10 codes such as “opioid use, unspecified” may overestimate harms. Third, although approximately two-thirds of our study population were eligible for the cohort requiring six months of continuous enrollment, results for the total study population (data not shown) were similar in direction and significance to those for the continuous enrollment cohort. Fourth, our Medicaid-specific findings from a single state might not be directly generalizable to all children, although 38 percent of US children are insured by Medicaid.<sup>12</sup> Finally, this cross-sectional analysis could not evaluate the causal association between opioid prescriptions and subsequent opioid-related harms as an adult.

### Study Results

**PREVALENCE OF EXPOSURES AND HARMS** Among 3,242,196 children enrolled in North Carolina Medicaid during 2016–18, each year 3.3 percent had one or more opioid prescription fills, 24.4 per 100,000 experienced adverse events, and 52.2 per 100,000 experienced other opioid-related harms (exhibit 1). Significant differences between age groups were identified for all exposure and harm categories ( $p < 0.001$ ), with adolescents ages 15–17 experiencing the highest prevalence of opioid prescription fills (10.8 percent), adverse events (54.9 per 100,000), and other opioid-related harms (223.5 per 100,000). Across all ages, the prevalence of one or more prescription fills per year decreased during the study period, as shown in appendix exhibit A2.<sup>10</sup>

**CHARACTERISTICS OF PEDIATRIC EXPOSURES AND HARMS** Of 137,710 opioid prescription fills among children during 2016–18, prescribers were most commonly physicians (35.5 percent), dentists (33.3 percent), and advanced practice providers (17.7 percent) (exhibit 2). Exhibit 2 also shows the types of physicians represented; surgeons were the most common type. The most common opioid prescription fill types were hydrocodone (44.9 percent), oxycodone (28.7 percent), and codeine (20.0 percent) (data not shown).

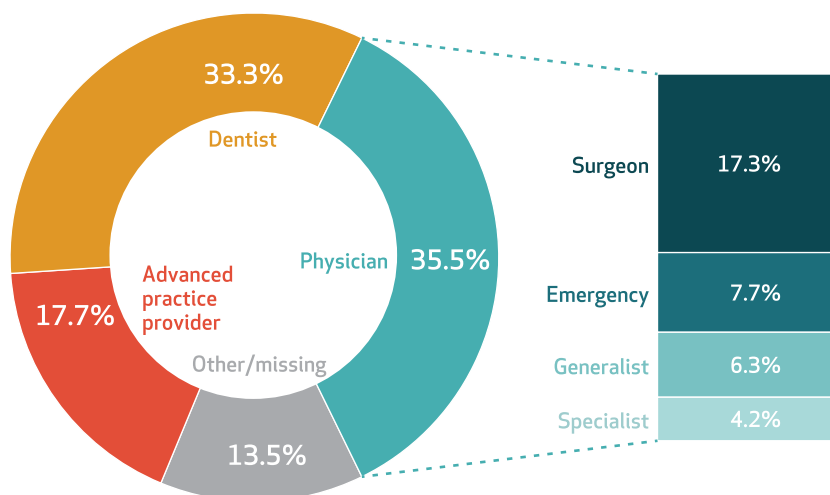
The prevalence of pediatric opioid prescription fills in the cohort of children with six months of continuous enrollment ( $n = 2,019,211$ ) increased significantly with the number of complex chronic conditions (from 2.7 percent for

zero conditions to 15.8 percent for four or more conditions; exhibit 3). The prevalence of opioid prescription fills also was higher for White (3.1 percent versus 2.7 percent Black) and rural-dwelling (3.4 percent versus 3.1 percent suburban and 2.7 percent urban) children. Opioid-related adverse events were more common in girls (26.2 per 100,000 versus 22.7 per 100,000 boys) and White children (27.5 per 100,000 versus 24.0 per 100,000 Black children), whereas other opioid-related harms were more common in boys (58.1 per 100,000 versus 45.9 per 100,000 girls) and Black (60.2 per 100,000 versus 51.7 per 100,000 White) and urban-dwelling (58.1 per 100,000 versus 49.0 per 100,000 suburban and 38.7 per 100,000 rural) children (exhibit 4).

For children ages 6–17, 48.4 percent of opioid adverse events were preceded by opioid prescription fills within the previous six months—and often within three days—with a higher proportion of Black versus White children having had a recent opioid prescription fill (exhibit 5). Oxycodone (26.6 percent) and hydrocodone (11.3 percent) were the most common opioid types.

## EXHIBIT 2

Prescribers of opioids to Medicaid-insured children in North Carolina, 2016–18



**SOURCE** Authors' analysis of North Carolina Medicaid claims data for 137,710 opioid prescription fills for beneficiaries ages 1–17, 2016–18. **NOTES** The advanced practice provider category includes nurse practitioners and physician assistants. Significant differences between prescriber types and between physician specialties were identified ( $p < 0.001$ ) using chi-square tests.

## EXHIBIT 3

Yearly prevalence of opioid prescription fill exposures among Medicaid-insured children in North Carolina, by age group and sociodemographic and clinical characteristics, 2017–18

Characteristics	All ages (N = 2,019,211)	Age, years			
		1–5 (n = 661,169)	6–11 (n = 790,539)	12–14 (n = 347,255)	15–17 (n = 220,248)
Sex					
Male	2.9%	1.3%	1.7%	4.5%	9.3%
Female	3.0	0.8	1.6	4.9	11.6
Race					
White	3.1	1.0	1.9	5.2	11.6
Black	2.7	1.1	1.5	4.4	9.3
Other	3.0	1.2	1.6	4.0	9.7
Urban/rural status					
Urban	2.7	1.0	1.5	4.3	9.8
Suburban	3.1	0.9	1.8	5.0	11.2
Rural	3.4	1.3	2.0	5.4	11.5
Complex chronic conditions					
0	2.7	0.9	1.5	4.4	10.0
1	6.5	3.0	4.4	7.7	14.6
2	9.9	5.5	9.3	12.2	17.6
3	12.8	8.0	13.9	16.5	20.4
4 or more	15.8	11.2	16.6	21.1	30.4

**SOURCE** Authors' analysis of North Carolina Medicaid claims data for beneficiaries ages 1–17 with at least six months of continuous enrollment before January 1 of calendar years 2017 and 2018. **NOTES** Calendar year 2016 was not analyzed because of the six-month continuous enrollment criterion. Within each age group, subgroups are significantly different ( $p < 0.001$ ) using chi-square tests or Cochran-Armitage test (complex chronic conditions categories). Values reflect less than 1 percent missing data for race and urban/rural status.

## EXHIBIT 4

## Opioid harms among Medicaid-insured children in North Carolina, by sociodemographic characteristics, 2016–18

Characteristics	Total number	Opioid-related adverse events		Other opioid-related harms	
		Number	Prevalence per 100,000	Number	Prevalence per 100,000
Sex			**		****
Male	1,654,687	376	22.7	962	58.1
Female	1,587,509	416	26.2	729	45.9
Age, years			****		****
1–5	1,036,623	309	29.8	129	12.4
6–11	1,236,172	108	8.7	198	16.0
12–14	545,276	142	26.0	416	76.3
15–17	424,125	233	54.9	948	223.5
Race			****		****
White	1,586,869	436	27.5	820	51.7
Black	1,161,046	279	24.0	699	60.2
Other	489,765	77	15.7	161	32.9
Urban/rural status					****
Urban	2,038,169	472	23.2	1,185	58.1
Suburban	393,660	103	26.2	193	49.0
Rural	809,442	216	26.7	313	38.7

**SOURCE** Authors' analysis of North Carolina Medicaid claims data for beneficiaries ages 1–17, 2016–18. **NOTES** Yearly prevalence is reported per 100,000 patients. For each harm type (adverse event, other opioid-related harms), differences within subgroups were evaluated using chi-square tests. Values reflect less than 1 percent missing data for race and urban/rural status. \*\* $p < 0.05$  \*\*\*\* $p < 0.001$

## EXHIBIT 5

## Opioid prescription fill exposures before index opioid harms among Medicaid-insured children in North Carolina ages 6–17, 2016–18

Characteristics	Opioid-related adverse events (n = 417)	Other opioid-related harms (n = 1,186)
Total with opioid prescription fills in prior 6 months (%)	48.4	9.4
Age, years (%)		
6–11	61.8	7.9
12–14	47.0	5.8
15–17	44.7	11.3
Race (%)		
White	35.7	11.1
Black	59.9	7.7
Other	53.4	$n < 11^a$
Most recent opioid type (for those with fill in prior 6 months) (%)		
Oxycodone	26.6	3.3
Hydrocodone	11.3	3.2
Days since last fill (for those with fill in prior 6 months)		
Median	3.0	67.0
(Quartile 1, quartile 3)	(0.0, 19.0)	(5.0, 112.5)
Mean	20.0	68.5
(Standard deviation)	(36.7)	(58.4)

**SOURCE** Authors' analysis of North Carolina Medicaid claims data for beneficiaries ages 1–17 with at least one opioid-related harm and six months of continuous Medicaid enrollment before the harm, July 2016–December 2018. **NOTES** Each cell in the age and race rows represents the proportion of children in that subgroup with an opioid prescription fill in the prior six months (for example, among those ages 6–11 with an opioid-related adverse event, 61.8 percent had a prior opioid prescription fill). Children ages 1–5 are not presented because of small sample sizes. <sup>a</sup>Denotes suppressed values resulting from data reporting restrictions.

## Discussion

The results of this study further quantify how children have been impacted by opioids and identify disparities by sociodemographic and clinical characteristics. Our findings that more than half of the adverse events reported were preceded by a recent opioid prescription fill suggest a role that the children's own prescriptions may play in subsequent harms. Finally, we identified that children are prescribed opioids by several distinct types of clinicians.

Our findings that opioid exposures and harms disproportionately affect older adolescents compared with younger children are consistent with previous literature.<sup>6</sup> The increased prevalence of opioid exposures among youth with chronic conditions (for example, cancer and sickle cell anemia) may reflect opioids being appropriately prescribed, as previously reported.<sup>9</sup>

Our findings that Black and urban children were less likely than their counterparts to fill opioid prescriptions or experience adverse events but more likely to experience other opioid-related harms (for example, abuse and dependence) increase the call for future studies to explore racial and geographic opioid-related inequities in children.<sup>3,7,8,13</sup>

We identified preceding opioid prescription fills in almost 50 percent of adverse events, which may suggest a temporal relationship between children's own prescriptions and subsequent harms. In a 1999–2014 study in Tennessee, 89 percent of chart-adjudicated opioid adverse events were linked to children's prescriptions.<sup>6</sup> Other adverse events may involve sources of opioids not captured in our data set; exposure to family members' prescriptions, for example, puts adolescents at increased risk for opioid

overdose.<sup>11</sup> Relative to adverse events, fewer recent prescriptions were identified among youth with other opioid-related harms; these findings are similar to national data that indicate that about a quarter of adolescents ages 12–17 reported the source of their misused opioids as legitimate prescriptions.<sup>14</sup>

In addition to dentists, who prescribed approximately one-third of opioids to children,<sup>15</sup> advanced practice providers and surgeons together accounted for another one-third of prescriptions. These three groups often prescribe opioids to children for postprocedural pain.<sup>15,16</sup> The distinct and separate groups of clinicians who prescribe opioids to children suggest the need for pediatric opioid prescribing guidelines, particularly for postprocedural pain. Professional societies are well positioned to tailor general guidance for their clinicians and patients.<sup>17</sup>

## Policy Implications

There is an urgent need to prioritize children in federal and state policy and public health measures addressing the opioid epidemic. In addition to pediatric-specific opioid prescribing guidelines, opioid-related harms may be reduced by the dissemination of best practices on opioid safe storage and disposal, naloxone prescribing, and substance use screening and treatment among youth.<sup>2,18</sup> Stratifying population-level opioid surveillance reports by age and race is needed, given the distinct patterns of exposures and harms in different groups of children. Expected opioid pharmaceutical settlement payouts should support child-centered strategies that are racially and geographically equitable. ■

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## NOTES

- 1 Substance Abuse and Mental Health Services Administration. Treatment Episode Data Set (TEDS), 2017: admissions to and discharges from publicly-funded substance use treatment [Internet]. Rockville (MD): SAMHSA; 2019 [cited 2020 Aug 20]. Available from: [https://www.dasis.samhsa.gov/dasis2/teds\\_pubs/TEDS-2017-R.pdf](https://www.dasis.samhsa.gov/dasis2/teds_pubs/TEDS-2017-R.pdf)
- 2 Uchitel J, Hadland SE, Raman SR, McClellan MB, Wong CA. The opioid epidemic: a needed focus on adolescents and young adults. Health Affairs Blog [blog on the Internet]. 2019 Nov 21 [2020 Aug 20]. Avail-

able from: <https://www.healthaffairs.org/doi/10.1377/hblog20191115.977344/full/>

- 3 Gaither JR, Shabanova V, Leventhal JM. US national trends in pediatric deaths from prescription and illicit opioids, 1999–2016. *JAMA Netw Open*. 2018;1(8):e186558.
- 4 Kane JM, Colvin JD, Bartlett AH, Hall M. Opioid-related critical care resource use in US children's hospitals. *Pediatrics*. 2018;141(4):e20173335.
- 5 Gummin DD, Mowry JB, Spyker DA, Brooks DE, Beuhler MC, Rivers LJ, et al. 2018 annual report of the

American Association of Poison Control Centers' National Poison Data System (NPDS): 36th annual report. *Clin Toxicol (Phila)*. 2019; 57(12):1220–413.

- 6 Chung CP, Callahan ST, Cooper WO, Dupont WD, Murray KT, Franklin AD, et al. Outpatient opioid prescriptions for children and opioid-related adverse events. *Pediatrics*. 2018;142(2):e20172156.
- 7 Tomaszewski DM, Arbuckle C, Yang S, Linstead E. Trends in opioid use in pediatric patients in US emergency departments from 2006 to 2015. *JAMA Netw Open*. 2018;1(8):

- e186161.
- 8 Carmona J, Maxwell JC, Park JY, Wu LT. Prevalence and health characteristics of prescription opioid use, misuse, and use disorders among U.S. adolescents. *J Adolesc Health*. 2020;66(5):536–44.
  - 9 Feinstein JA, Rodean J, Hall M, Douppnik SK, Gay JC, Markham JL, et al. Outpatient prescription opioid use in pediatric Medicaid enrollees with special health care needs. *Pediatrics*. 2019;143(6):e20182199.
  - 10 To access the appendix, click on the Details tab of the article online.
  - 11 Nguyen AP, Glanz JM, Narwaney KJ, Binswanger IA. Association of opioids prescribed to family members with opioid overdose among adolescents and young adults. *JAMA Netw Open*. 2020;3(3):e201018.
  - 12 Henry J. Kaiser Family Foundation. Health insurance coverage of children 0–18 [Internet]. San Francisco (CA): KFF; 2020 [cited 2020 Aug 20]. Available from: <https://www.kff.org/other/state-indicator/children-0-18/>
  - 13 Hoffman KM, Trawalter S, Axt JR, Oliver MN. Racial bias in pain assessment and treatment recommendations, and false beliefs about biological differences between blacks and whites. *Proc Natl Acad Sci U S A*. 2016;113(16):4296–301.
  - 14 Park JY, Wu LT. Sources of misused prescription opioids and their association with prescription opioid use disorder in the United States: sex and age differences. *Subst Use Misuse*. 2020;55(6):928–36.
  - 15 Gupta N, Vujicic M, Blatz A. Opioid prescribing practices from 2010 through 2015 among dentists in the United States: what do claims data tell us? *J Am Dent Assoc*. 2018; 149(4):237–245.
  - 16 Iobst CA, Singh S, Yang JZ. Opioid prescription patterns for pediatric orthopaedic fracture patients. *J Clin Orthop Trauma*. 2020;11(2):286–90.
  - 17 Cravero JP, Agarwal R, Berde C, Birmingham P, Coté CJ, Galinkin J, et al. The Society for Pediatric Anesthesia recommendations for the use of opioids in children during the perioperative period. *Paediatr Anaesth*. 2019;29(6):547–71.
  - 18 Hadland SE, Bagley SM. Opioid prescribing patterns and subsequent overdose. *JAMA Pediatr*. 2019 Dec 16. [Epub ahead of print].