

Drug Overdose Deaths in Colorado: Final Data for 2010-2020

Christine Demont, MPH; Kylie Yocum, MPH, Kirk Bol, MSPH

Introduction

Nationally and in Colorado, drug use disorders and fatal overdoses remain significant public health concerns.¹ Deaths involving synthetic opioids other than methadone (such as fentanyl) have increased nationally since 2013² and have risen in prominence in Colorado since 2016. The Colorado Department of Public Health and Environment (CDPHE) is monitoring the severity of the epidemic using a variety of available data, including mortality data from death certificates registered in Colorado. This report highlights trends in drug overdose deaths among Colorado residents and describes differences in drug overdose deaths among certain populations and involving various drug types.

Methods

CDPHE's Vital Statistics Program manages the analysis and dissemination of mortality data collected through the routine registration of death certificates in Colorado. Mortality data analyzed for this report represent drug overdose deaths from 2010-2020 among Colorado residents. International Classification of Disease, 10th Revision (ICD-10) codes for cause of death were used to identify fatal drug overdoses, using published definitions from the Centers for Disease Control and Prevention's National Center for Health Statistics, as shown in Appendix 1.^{1,3,4,5} Text field searches for "fentanyl" within death certificate data were used for fentanyl-specific analyses because there is no fentanyl-specific ICD-10 code available for querying.

Drug overdose deaths (also referred to as drug overdoses in this report) were further classified according to the involvement of specific substances, including prescription opioids, fully-synthetic opioids (including all forms of fentanyl), heroin, cocaine, and methamphetamine (including other psychostimulants with abuse potential). A single overdose death may involve more than one type of drug; in these cases, the death is included in the counts and rates of each applicable drug type (unless otherwise noted). Therefore, counts and rates presented for a singular drug type may have co-involvement of other drugs, reflecting the nuance of polysubstance use. The frequency and nature of drug overdose deaths with co-involvement of fentanyl were also explored in this report. Additionally, manner of death, or intent, of the overdose was considered, including unintentional (accidental), intentional self-harm (suicide), and those of undetermined intent. Intentional assault using drugs, or homicides, are rare and therefore were not included in this report.

All death rates are presented as deaths per 100,000 population. Unless otherwise marked, all rates are age-adjusted to ensure comparability between occurrence of deaths over time, across geographic areas, and between demographic groups. All age-adjusted rates were computed using the direct method and applying the 2000 U.S.

Standard Population.⁶ Population estimates used to compute rates reflect June 2020-based estimates from the Colorado Demography Office, Colorado Department of Local Affairs.

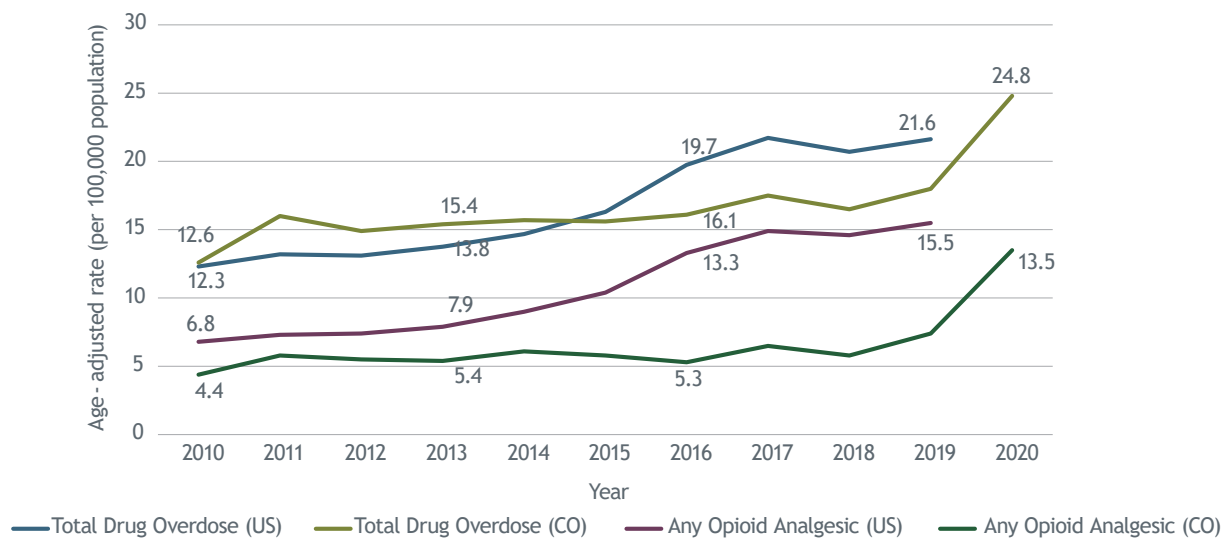
Drug overdoses were also examined for demographic variability. Characteristics explored include sex, age, race and ethnicity (Hispanic origin) of the decedent, geographic county of residence,⁷ and area/community-based poverty levels. Area-based poverty is measured by calculating the percent of the population in each decedent's census tract of residence that is living at or below the federal poverty level.⁸ These population data come from the 2015-2019 five-year American Community Survey estimates made available by the U.S. Census Bureau. The poverty level categories used in this report include 0-9.9% of the population in a decedent's community living at or below the federal poverty level, 10-19.9%, 20-29.9%, and 30% or greater.

Results

Overall drug overdose trends

From 2010 to 2020, there were 10,334 drug overdose deaths among Colorado residents, and during this time period, rates increased nearly every year. In 2010 the number of total overdoses was 653 residents (12.6 deaths per 100,000 population); in 2020 the number of total overdoses more than doubled to 1,477 residents (24.8 deaths per 100,000). Until 2015, Colorado's rate of overdose death was higher than the national rate; however, the national rate has exceeded Colorado's rate since 2015. Both Colorado's overdose death rate and the nation's rate have continued to increase in the most recent years of data available. The 2020 data indicates a marked increase in Colorado's overdose death rate; and though official 2020 age-adjusted rates are not yet available for the United States, provisional counts also indicate a continued increase.⁹ Similarly, opioid overdose rates increased from 2010-2020 for both Colorado and the United States and are a lead contributor to the increase in total drug overdose deaths. The opioid overdose rates began to increase notably after 2013 in the United States, and after 2018 in Colorado. More detail on opioid drug overdose deaths are explored in this report (Figure 1).

Figure 1: Age-adjusted drug overdose death rates (total and any opioid), United States and Colorado residents, 2010-2020.



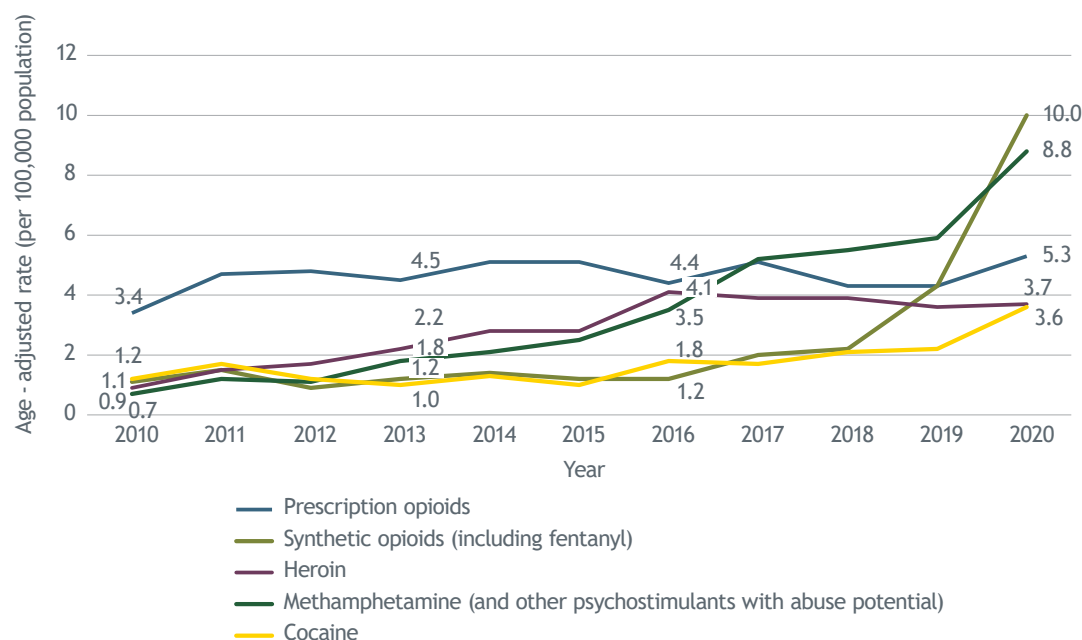
Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

Opioids, especially fully-synthetic opioids including fentanyl, continue to propel the overdose epidemic in Colorado. Since 2010, the overdose rate involving prescription opioids remained relatively constant, with

an age-adjusted rate of 3.4 deaths per 100,000 population in 2010 increasing to 5.3 per 100,000 in 2020. Overdose deaths involving illicit opioids like heroin have increased since 2010, with an age-adjusted rate of 0.9 deaths per 100,000 population in 2010 that then peaked in 2016 at 4.1 per 100,000 and decreased slightly to a rate of 3.7 per 100,000 in 2020. From 2010-2016, overdose deaths involving synthetic opioids such as fentanyl and its analogs (but excluding methadone) remained relatively constant around a rate of 1.2 deaths per 100,000 population but increased markedly to 10.0 per 100,000 in 2020.

Overdose deaths involving psychostimulants with abuse potential, among which methamphetamine is the most prevalent, have become more common, increasing from a relatively stable rate of 0.9 deaths per 100,000 population in 2010 to 8.8 per 100,000 in 2020. Additionally, overdose deaths involving cocaine declined in the period 2010-2013, then increased from a rate of 1.0 death per 100,000 population in 2013 to 3.6 per 100,000 in 2020 (Figure 2).

Figure 2. Age-adjusted drug overdose death rates involving prescription opioids, heroin, cocaine, methamphetamine (and other psychostimulants with abuse potential) and synthetic opioids other than methadone: Colorado residents, 2010-2020.



Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

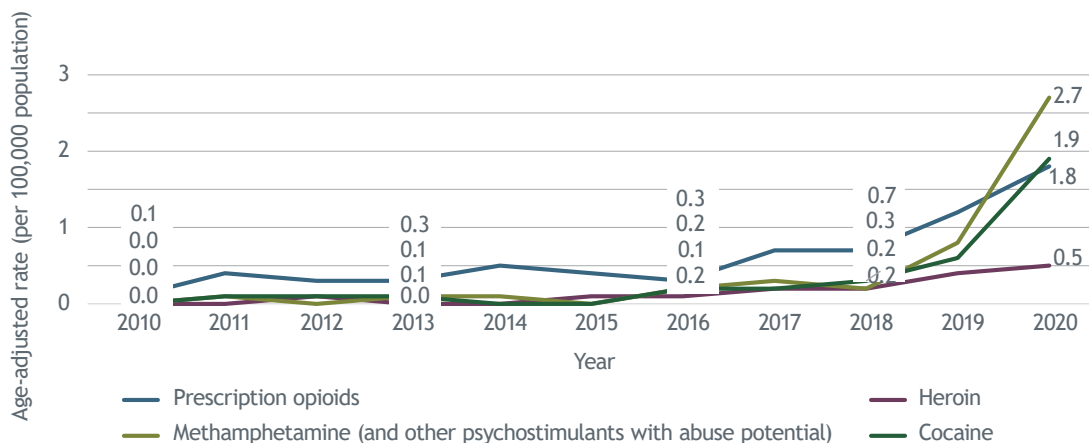
Note: Deaths involving more than one type of drug were included in the rates for each applicable category, therefore, the drug categories are not mutually exclusive.

Drug overdose trends by co-involvement of multiple drug types and fully-synthetic opioids (including fentanyl and its analogs)

The increase in overdose deaths involving fentanyl precipitated the need to analyze overdose deaths with the co-involvement of fully synthetic opioids (predominantly fentanyl and its analogs) and other drug types. Drug overdose rates for prescription opioids with the co-involvement of fully-synthetic opioids remained stable around 0.2 deaths per 100,000 population from 2010-2016, rose to 0.7 per 100,000 in 2018, and increased further to 1.8 per 100,000 in 2020. Overdose deaths for methamphetamine (and other psychostimulants with abuse potential) had almost no co-involvement with fully-synthetic opioids until 2018 with a rate of 0.2 deaths per 100,000 population, but increased to 2.7 per 100,000 in 2020, representing the highest burden of co-involvement of fully-synthetic opioids with any drug. Similarly, overdose deaths for cocaine had low co-involvement with fully-synthetic opioids until 2018 with a rate of 0.3 deaths per 100,000 population and

increased to 1.9 per 100,000 in 2020. Drug overdose deaths for heroin with co-involvement of fully-synthetic opioids remained relatively stable and rare throughout 2010-2020, with a rate of 0.1 deaths per 100,000 in 2016 and increased to 0.5 deaths per 100,000 in 2020 (Figure 3).

Figure 3. Age-adjusted drug overdose death rates with fully-synthetic opioid involvement: Colorado residents, 2010-2020.

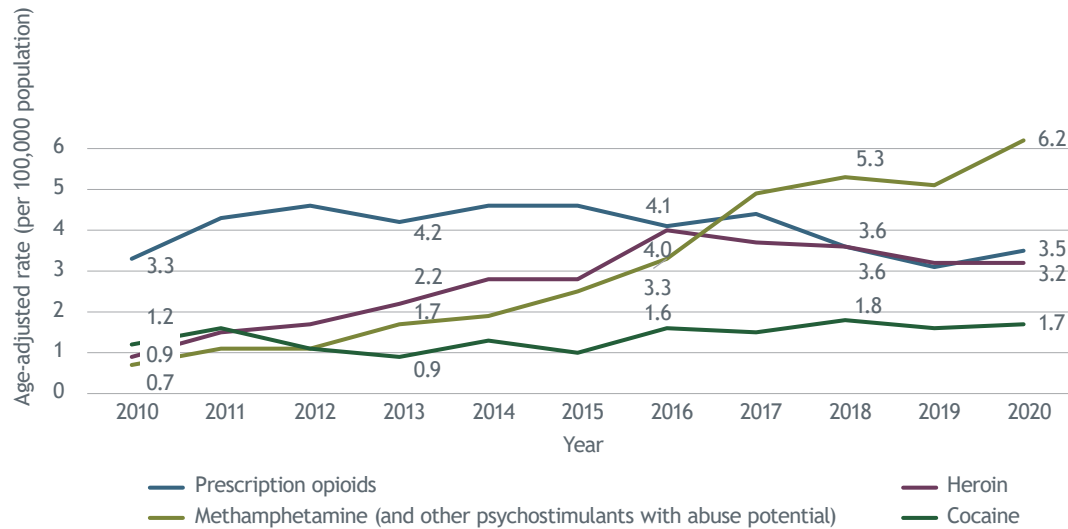


Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

Note: Deaths involving more than one type of drug were included in the rates for each category, therefore, the drug categories are not mutually exclusive.

Conversely, analyzing the changes in age-adjusted drug overdose death rates that do not co-involve fully-synthetic opioids like fentanyl can provide insight on the extent to which fentanyl and its analogs have driven the recent upward trends in overdose deaths. Overdose deaths involving prescription opioids and excluding co-involvement of fully-synthetic opioids peaked from 2011-2015 with less than 5.0 deaths per 100,000 population, and declined to 3.5 per 100,000 in 2020. Overdose deaths involving methamphetamine (and other psychostimulants with abuse potential) and excluding co-involvement of fully-synthetic opioids steadily increased from 2010-2020, with a rate of 0.7 deaths per 100,000 population in 2010, increased to 3.3 per 100,000 in 2016, and increased further to 6.2 per 100,000 in 2020. Overdose deaths involving cocaine and excluding co-involvement of fully-synthetic opioids represented 1.2 deaths per 100,000 population in 2010, decreased slightly to 0.9 per 100,000 in 2013, and increased to 1.7 in 2020. Overdose deaths involving heroin excluding co-involvement of fully-synthetic opioids represented 0.9 deaths per 100,000 population in 2010, increased to 4.0 per 100,000 in 2016, and declined slightly to 3.2 per 100,000 in 2020 (Figure 4).

Figure 4. Age-adjusted drug overdose death rates without involvement of fully-synthetic opioids: Colorado residents, 2010-2020.



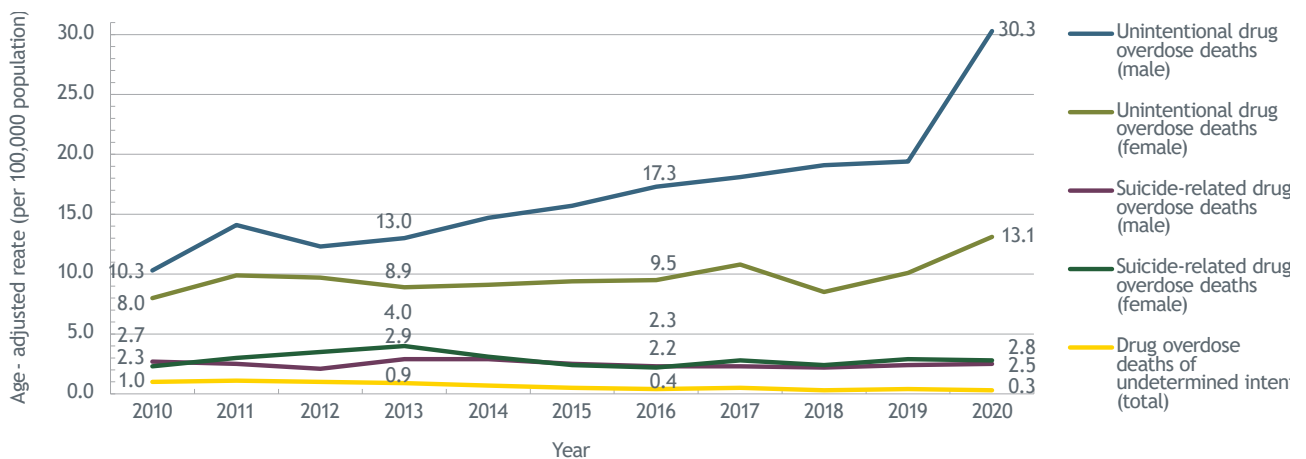
Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

Note: Deaths involving more than one type of drug were included in the rates for each category, therefore, the drug categories are not mutually exclusive.

Drug overdose trends by sex and manner of death

Since 2010, rates of unintentional (or accidental) drug overdose deaths have increased in both men and women. Among men, rates of unintentional drug overdose increased from 10.3 deaths per 100,000 population in 2010 to 30.3 per 100,000 in 2020. Rates of unintentional drug overdose death among women were consistently lower than those among men and had a slower rate of increase (8.0 in 2010 to 13.1 in 2020). Rates of suicide-related drug overdose death among both men and women remained consistent during the period 2010-2020; while the differences between men and women for rates in suicide-related overdose death were small, rates were consistently slightly higher in women. Drug overdose deaths of undetermined intent (that is, when intent cannot be established at the legally defined level by the investigating coroner, medical examiner, or physician) decreased consistently between 2010-2020 (1.0 to 0.3), reaching new lows in recent years, which again represents an improvement in the completeness of deaths of known manner, and may explain in part these changes in unintentional and suicide-related overdoses (Figure 5).

Figure 5. Age-adjusted drug overdose death rates by sex and manner of death: Colorado residents, 2010-2020.



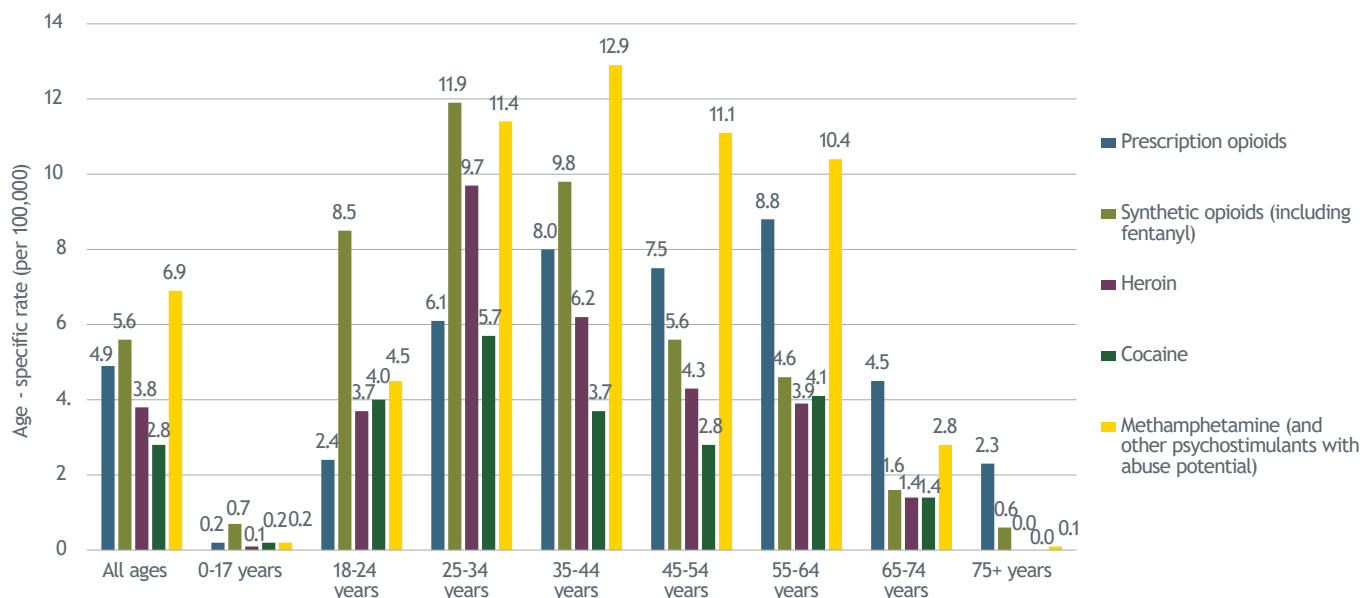
Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

Note: Deaths involving more than one type of drug were included in the rates for each category, therefore, the drug categories are not mutually exclusive.

Drug overdose trends by age, race/ethnicity, geography, and poverty

During the time period of 2018-2020, Coloradans ages 55-64 years had the highest rate of overdose mortality involving prescription opioids (8.8 deaths per 100,000 population) compared to 35-44 year-olds (8.0 per 100,000) and 45-54 year-olds (7.5 per 100,000). Coloradans ages 25-34 years had the highest rate of overdose mortality involving synthetic opioids (11.9 per 100,000) compared to 35-44 year-olds (9.8 per 100,000) and 18-24 years (8.5 per 100,000). Similarly, the highest rates of overdose mortality involving heroin occurred among 25-34 year-olds and 35-44 year-olds. Specifically, the rate of overdose mortality involving heroin among 25-34 year-olds was 9.7 deaths per 100,000; 35-44 year-olds was 6.2 per 100,000; and 45-54 year-olds was 4.3 per 100,000. The rate of overdose mortality involving cocaine also varied by age group, and the groups with the highest rates were: 25-34 year-olds, 5.7 deaths per 100,000; 55-64 year-olds, 4.1 per 100,000; and 18-24 year-olds, 4.0 per 100,000. Coloradans aged 35-44 years had the highest rate of overdose mortality involving methamphetamine (and other psychostimulants with abuse potential) (12.9 per 100,000) compared to 25-34 year-olds (11.4 per 100,000) and 45-54 year-olds (11.1 per 100,000). Methamphetamine (and other psychostimulants with abuse potential) represented the highest age-specific overdose mortality rates (more than 10 deaths per 100,000 for four age groups), compared to other drugs. Only synthetic opioids (including fentanyl) had a similar rate among only one age group, 25-34 year-olds (Figure 6).

Figure 6. Age-specific drug overdose death rates by involvement of specific drug categories: Colorado residents, 2018-2020 combined.



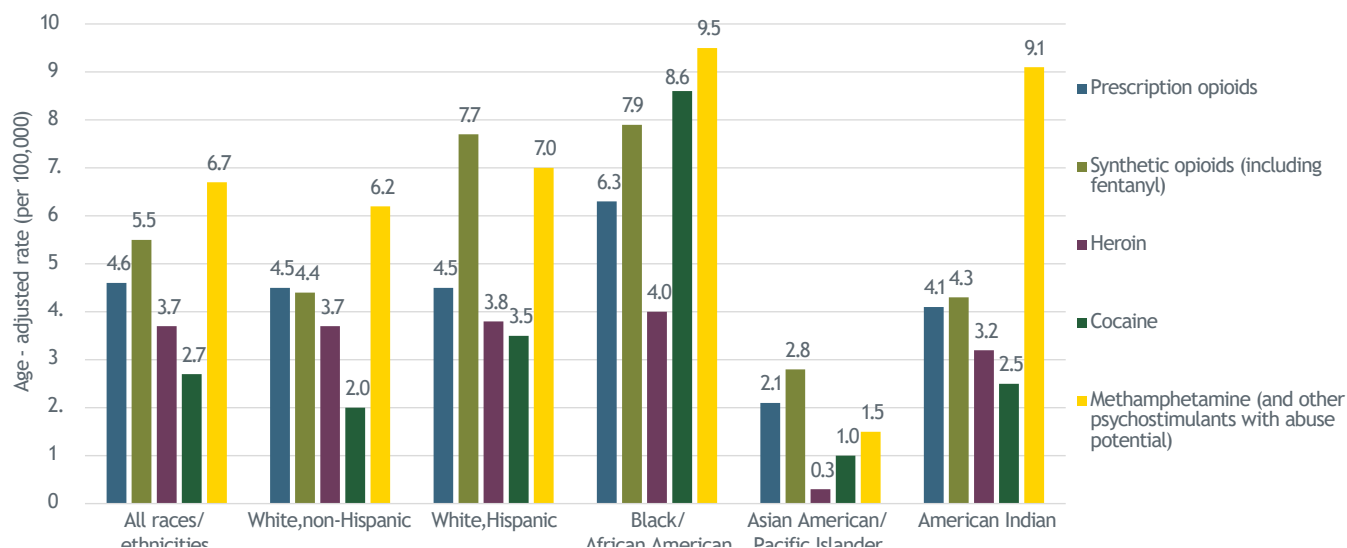
Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

Note: Deaths involving more than one type of drug were included in the rates for each category, therefore, the drug categories are not mutually exclusive.

During the time period 2018-2020, total drug overdose death rates were highest among Colorado's Black/African American population (26.9 per 100,000); however, only slightly lower rates occurred across the White, Hispanic population (21.6 per 100,000), American Indian/Native Alaskan population (19.9 per 100,000), and White, non-Hispanic population (18.2 per 100,000). Rates among Colorado's Asian/Pacific Islander population had the lowest rate of total drug overdose deaths (6.5 per 100,000) and the lowest rates of the specific drugs examined in this report (Figure 7).

Race/ethnicity-specific rates of overdose death involving methamphetamine (and other psychostimulants with abuse potential) were higher than the rates involving other specific drug types examined in this report for most populations, except for White, Hispanic Coloradans and Asian American/Pacific Islander Coloradans, among both of which overdoses involving fully-synthetic opioids represent the greatest burden of overdose mortality. Rates of overdose death involving heroin were relatively constant across racial groups, with the exception of Asian American/Pacific Islander Coloradans, among whom the rate was very low. The rate of overdose deaths involving cocaine was highest among Black/African Americans (8.6 deaths per 100,000), nearly three times higher than for any other race/ethnic group (Figure 7).

Figure 7. Age-adjusted drug overdose death rates, by race/ethnicity and involvement of specific drug categories: Colorado residents, 2018-2020 combined.

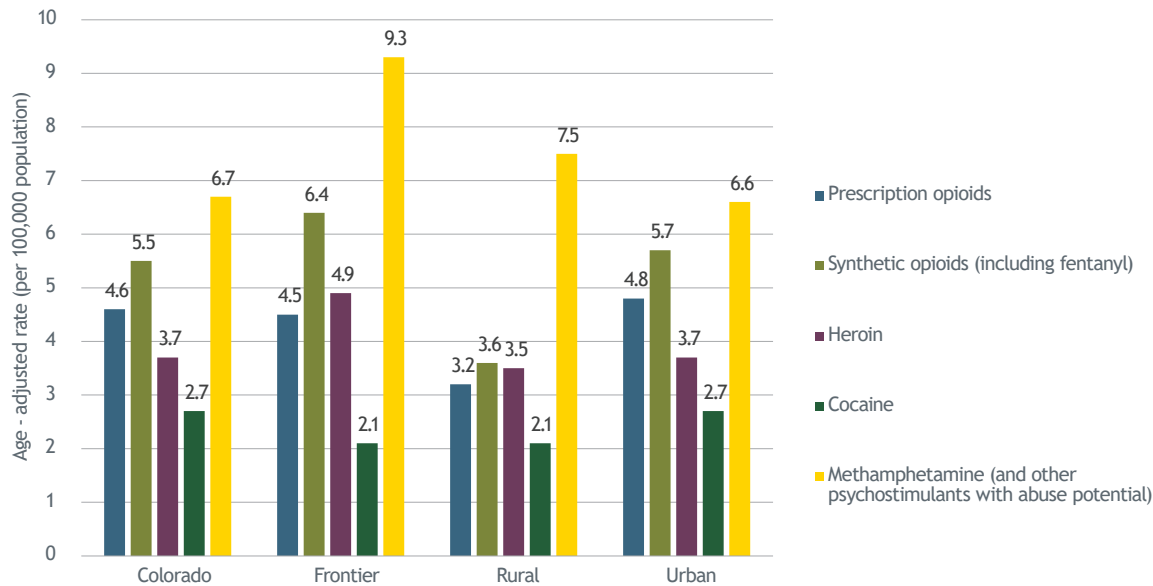


Source: Vital Statistics Program, Colorado Department of Public Health and Environment

Note: Deaths involving more than one type of drug were included in the rates for each category, therefore, the drug categories are not mutually exclusive.

During 2018-2020, overdose deaths involving methamphetamine (and other psychostimulants with abuse potential) consistently had the highest rate in Colorado, not just in urban counties but also in rural and frontier counties. The highest rates of overdose death with methamphetamine (and other psychostimulants with abuse potential) involvement in 2018-2020 occurred among residents living in frontier counties (9.3 deaths per 100,000 population) compared to rural regions (7.5 per 100,000) and urban regions (6.6 per 100,000). Overdose death rates involving fully-synthetic opioids consistently had the second highest rate in frontier, rural, and urban counties: 6.4 deaths per 100,000 population in frontier counties, 3.6 per 100,000 in rural counties, and 5.7 per 100,000 in urban counties. The rates of overdose deaths involving heroin varied, from 4.9 per 100,000 in frontier counties, 3.5 per 100,000 in rural areas, and 3.7 per 100,000 in urban areas. Finally, the rates with prescription opioid involvement also varied across groups, from 4.5 per 100,000 in frontier counties, 3.2 per 100,000 in rural areas, and 4.8 per 100,000 in urban areas. The highest rates of overdose death with cocaine involvement occurred among residents living in urban areas (2.7 per 100,000), compared to rural areas (2.1 per 100,000) and frontier counties (2.1 per 100,000) (Figure 8).

Figure 8. Age-adjusted drug overdose death rates of specific drug categories by county of residence type: Colorado residents, 2018-2020 combined.

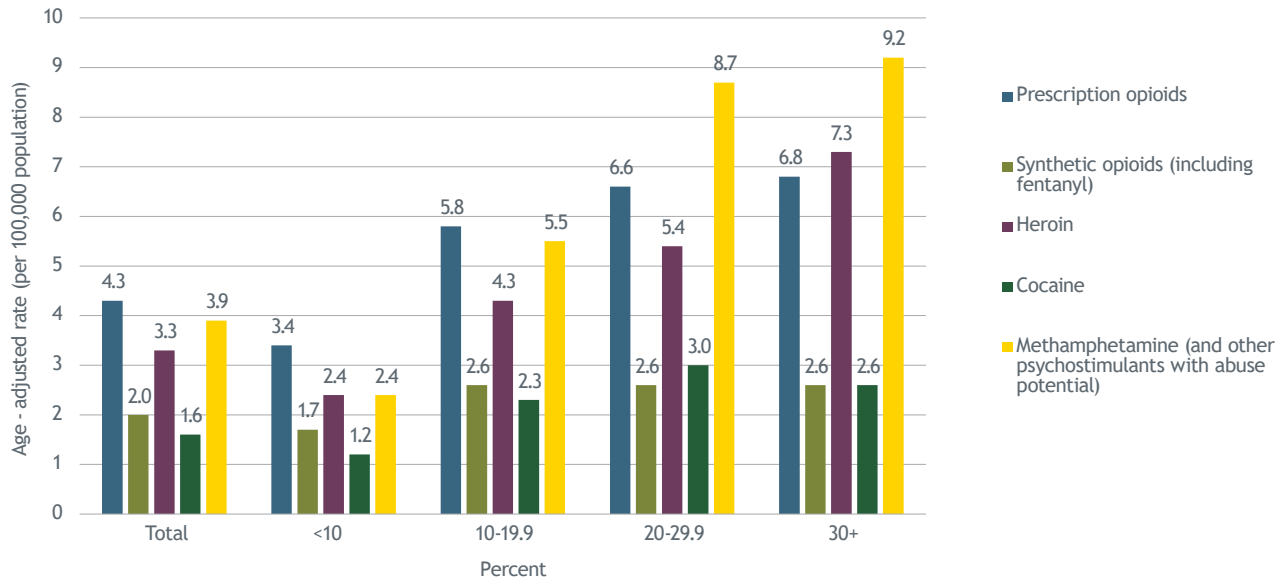


Source: Vital Statistics Program, Colorado Department of Public Health and Environment

Note: Deaths involving more than one type of drug were included in the rates for each category, therefore, the drug categories are not mutually exclusive.

During the time period 2015-2019 (representing the most current area-based data available from the U.S. Census Bureau's American Community Survey), drug overdose death rates involving prescription opioids, heroin, or methamphetamines consistently increased with increasing area-based poverty. Synthetic opioids (including fentanyl) and cocaine did not follow this pattern. Specifically, rates of overdoses involving methamphetamine (and other psychostimulants with abuse potential) increased across area-based poverty status categories, from <10% living at or below the federal poverty level (2.4 deaths per 100,000 population), 10-19.9% (5.5 per 100,000), 20-29.9% (8.7 per 100,000), and 30%+ (9.2 per 100,000). A similar trend was observed for drug overdose deaths involving prescription opioids, from <10% (3.4 per 100,000), 10-19.9% (5.8 per 100,000), 20-29.9% (6.6 per 100,000), and 30%+ (6.8 per 100,000); and overdose deaths involving heroin, from <10% (2.4 per 100,000), 10-19.9% (4.3 per 100,000), 20-29.9% (5.4 per 100,000), and 30%+ (7.3 per 100,000). The drug overdose death rates involving cocaine varied across area-based poverty status categories, from <10% (1.2 per 100,000), 10-19.9% (2.3 per 100,000), 20-29.9% (3.0 per 100,000), 30%+ (2.6 per 100,000); as did the overdose deaths rates involving fully-synthetic opioids, from <10% (1.7 per 100,000), 10-19.9% (2.6 per 100,000), 20-29.9% (2.6 per 100,000), and 30%+ (2.6 per 100,000) (See Figure 9).

Figure 9. Age-adjusted drug overdose death rates, by area-based poverty status and involvement of specific drug categories: Colorado residents, 2015-2019 combined.

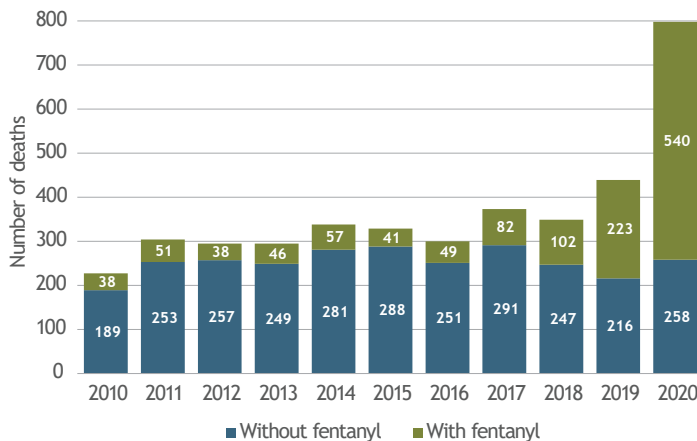


Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

Note: Deaths involving more than one type of drug were included in the rates for each category, therefore, the drug categories are not mutually exclusive.

Figure 10 presents the number of drug overdose deaths involving opioid analgesics with and without specific mention of “fentanyl” on death certificates for the time period 2010-2020. Opioid analgesics include all natural and semi-synthetic opioids (ICD-10 code T40.2), methadone (T40.3), and fully-synthetic opioids (T40.4). Fully-synthetic opioids in turn include fentanyl and its analogs. Drug overdose deaths involving opioid analgesics, but without fentanyl, remained consistent throughout the time period; however, the number of prescription drug overdose deaths involving opioid analgesics along with specific mention of “fentanyl” on the death certificate increased from 102 deaths in 2018 to 223 deaths in 2019, and further increased to 540 deaths in 2020. The presence of fentanyl was largely consistent at around 15% of opioid drug overdose deaths from 2010 to 2016. However, starting in 2017, fentanyl constituted a larger proportion of prescription drug overdose deaths, with a prevalence of 22% in 2017, then increased to 51% in 2019, and peaked at 67.6% in 2020 (Figure 10).

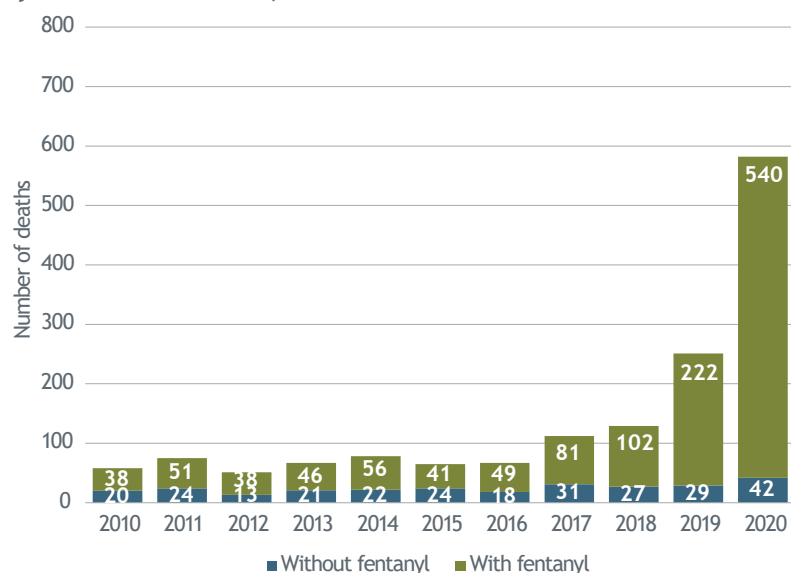
Figure 10. Number of drug overdose deaths involving opioid analgesics with and without specific mention of “fentanyl”: Colorado residents, 2010-2020.



Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

Also of interest is the further analysis of the category of fully-synthetic opioids (ICD-10 code T40.4), which includes fentanyl, but also other fully-synthetic opioids such as tramadol and pethidine. Up until 2018, the proportion represented by fentanyl in overdoses involving fully-synthetic opioids was always high, but did not exceed 80%. However, this proportion increased to 88% in 2019 and 93% in 2020. During this time, the number of drug overdose deaths involving fully-synthetic opioids increased (129 deaths in 2018, 251 deaths in 2019, and 582 deaths in 2020); while the number not involving fentanyl specifically remained relatively constant (27 deaths in 2018, 29 in 2019, and 42 in 2020), highlighting the significant contribution of fentanyl in these recent trends in overdose deaths involving fully-synthetic opioids (Figure 11).

Figure 11. Number of drug overdose deaths involving fully synthetic opioids only with and without specific mention of “fentanyl”: Colorado residents, 2010-2020.



Source: Vital Statistics Program, Colorado Department of Public Health and Environment.

Discussion

During the time period 2010-2020, numbers of drug overdose deaths and overdose death rates in Colorado more than doubled, driven by increases in drug overdose deaths involving fully-synthetic opioids, namely fentanyl, as well as methamphetamine (and other psychostimulants with abuse potential). The fatal overdose rate involving fully-synthetic opioids increased ten-fold during the period, and fentanyl represented the majority of fully synthetic opioids involved. These trends reflect similar national patterns in synthetic opioid and stimulant overdose death since 2013.² CDPHE has concentrated its overdose prevention efforts on educating health care providers about prescribing guidelines, supporting collaborative community efforts to reduce the number of overdoses, increasing the capacity of local communities to respond to the crisis, and supporting increased access of naloxone to help prevent fatal overdoses.

Further information on CDPHE’s overdose prevention program can be found online at <https://cdphe.colorado.gov/overdose-prevention>. Efforts include the naloxone bulk purchase fund, medication take-back programs, and harm reduction collaboration. Also available through that webpage is the interactive Colorado Drug Overdose Dashboard, with data available on fatal and nonfatal overdoses as well as prescription data, which can be further explored at the county level.

Acknowledgements

The authors would like to thank all of the contributing staff at CDPHE, specifically those working in drug overdose mortality surveillance, epidemiology, and prevention. Additionally the authors would like to thank the Colorado Overdose Data-to-Action team. This work is supported by the Cooperative Agreement Number 1 NU17CE924988-03-00, funded by the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services.

Suggested Citation

Demont, C, Yocum K, Bol, KA. Drug Overdose Deaths in Colorado: Final Data for 2010-2020. HealthWatch 118. Denver, CO. Center for Health and Environmental Data, Colorado Department of Public Health and Environment. January, 2022.

Appendix 1: ICD-10 Drug Overdose Codes Used in Report

Category	Underlying Cause of Death (ICD-10)	Multiple Cause of Death (ICD-10, any mention)
Total Drug Overdose	X40-X44, X60-X64, X85, Y10-Y14	---
Any Opioid Analgesic (prescription and synthetic opioid)	X40-X44, X60-X64, X85, Y10-Y14	T40.2-T40.4
Prescription Opioid	X40-X44, X60-X64, X85, Y10-Y14	T40.2-T40.3 (with or without T40.4)
Synthetic Opioid (including fentanyl)	X40-X44, X60-X64, X85, Y10-Y14	T40.4
Heroin	X40-X44, X60-X64, X85, Y10-Y14	T40.1
Methamphetamine (and other psychostimulants with abuse potential)	X40-X44, X60-X64, X85, Y10-Y14	T43.6
Cocaine	X40-X44, X60-X64, X85, Y10-Y14	T40.5
Fentanyl	X40-X44, X60-X64, X85, Y10-Y14	T40.4 and mention of 'fentanyl' in text literals on death certificate
Methadone	X40-X44, X60-X64, X85, Y10-Y14	T40.3
Unintentional Drug Overdose	X40-X44	---
Suicide Overdose	X60-X64	---
Overdose with Undetermined Manner/Intent	Y10-Y14	---

Deaths involving more than one type of drug were included in the rates for each applicable drug category; categories are not mutually exclusive.

Cited References

1. Hedegaard H, Minino AM, Warner M. Drug overdose deaths in the United States, 1999-2017. NCHS Data Brief, no 329. Hyattsville, MD: National Center for Health Statistics. 2018.
2. Mattson C, Tanz L, Quinn K. Trends and Geographic Patterns in Drug and Synthetic Opioid Overdose Deaths--United States, 2013-2019. MMWR Morb Mortal Wkly Rep 2021;70:202-207. DOI: <http://dx.doi.org/10.15585/mmwr.mm7006a4>
3. Chen, LH, Hedegaard H, Warner M. Drug-poisoning deaths involving opioid analgesics: United States, 1999-2011. NCHS data brief, no 166. Hyattsville, MD: National Center for Health Statistics. 2014.
4. Hedegaard H, Warner M, Minino AM. Drug overdose deaths in the United States, 1999-2016. NCHS Data Brief, no 294. Hyattsville, MD: National Center for Health Statistics. 2017.
5. World Health Organization. (2016). The ICD-10 Classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines. Geneva: World Health Organization. Retrieved from: <https://icd.who.int/browse10/2016/en>
6. Klein RJ, Schoenborn CA. Age adjustment using the 2000 projected U.S. population. Healthy People Statistical Notes, no 20. Hyattsville, Maryland: National Center for Health Statistics. January 2001.
7. Geographic region defines each county in Colorado as urban, rural, or frontier as designated by The Colorado Rural Health Center, The State Office of Rural Health. Retrieved from: https://www.colorado.gov/pacific/sites/default/files/PCO_CHSC_CountyDesignations_2016.pdf
8. Colorado Department of Public Health and Environment (CDPHE). (2017). Colorado Births and Deaths, 2017, Notes Regarding Colorado's Area-Based Poverty Estimates. Denver, Colorado. Retrieved from: <https://cdphe.colorado.gov/center-for-health-and-environmental-data/registries-and-vital-statistics/vital-statistics-program>
9. Ahmad FB, Rossen LM, Sutton P. Provisional drug overdose death counts. National Center for Health Statistics. 2021.