WILLIAM L. JENKINS FORENSIC CENTER
EAST TENNESSEE STATE UNIVERSITY

Drug-Related Deaths

2022-2024

William L. Jenkins Forensic Center
ETSU Division of Forensic Pathology
Box 70425
Johnson City, TN 37614
(423) 439-8038

Table of Contents

I. Overview and Methodology

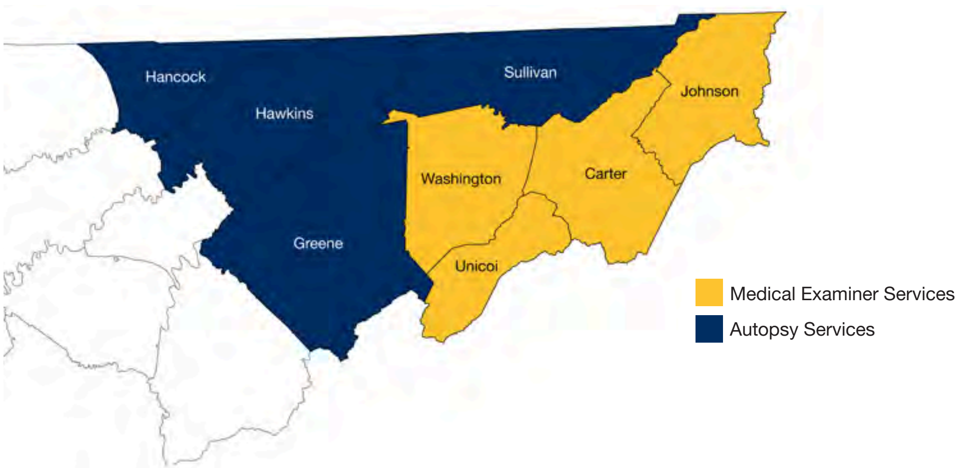
William L. Jenkins Forensic Center Operations

The William L. Jenkins Forensic Center is the Forensic Pathology Division and under the purview of the Department of Pathology with East Tennessee State University's Quillen College of Medicine. It serves as the Office of the Chief Medical Examiner for Washington, Carter, Unicoi and Johnson Counties and provides autopsy and consultative services for four other counties (Greene, Hancock, Hawkins, Sullivan Counties) in northeast Tennessee.

Jurisdictional counties (yellow on Map 1.1 below) are those where Dr. Emilie Cook is the Chief Medical Examiner (ME). For Washington County the Regional Forensic Center (RFC) investigators serve as county Medicolegal Death Investigators (MDI). In Carter, Johnson, and Unicoi each county has a Field Medicolegal Death Investigator (FMDI) appointed to serve as primary death investigator and report to the RFC. The RFC investigators will also respond to sudden unexplained infant deaths, homicides, multiple fatalities, and deaths deemed suspicious alongside the FMDI in Carter, Johnson and Unicoi Counties.

Non-jurisdictional counties (blue on Map 1.1) are those where there is an appointed county Medical Examiner (not Dr. Emilie Cook or one of the RFC Deputy Medical Examiners). The county ME is a physician licensed in Tennessee and responsible for conducting medicolegal death investigative activities. These agencies may or may not also have MDIs working in their counties.

Map 1.1 Regional Forensic Center Coverage Map



In general, the deaths investigated by our office include those that are sudden, unexpected, often times violent, and not readily explainable at the time of death.

Because deaths occur regardless of time or day, the ME's office responds to deaths 24 hours per day, 365 days per year. These deaths are investigated by MDIs that arrive to death scenes to gather information from families and law enforcement, and examine/photograph the body and surroundings. This information will be relayed to Forensic Pathologists for case management.

We refer the reader to the annual reports published by WLJFC yearly from 2022 to present for a complete description of RFC activities. These reports are available on our website at https://www.etsu.edu/com/pathology/forensic-center/default.php.

Defining Drug-Related Deaths

The objective of a medicolegal death investigation is ultimately to determine the cause and manner of death of the decedent. The cause of death is a description of the specific injury or medical scenario resulting in death, whereas the manner of death refers to the circumstances surrounding the death. In Tennessee, the manner of death will be one of the following: natural, accident, suicide, homicide, or "could not be determined," which for the remainder of this report will be described more concisely as *undetermined*.

The official cause and manner of death of record is stated on the death certificate, and the majority of mortality statistics are tabulated using death certificates exclusively. To standardize this process, as system known as the International Classification of Disease was developed; we currently use the 10th revision of this system, so it is typically referred to as "ICD-10 coding." This coding process occurs at the state and national levels once a death certificate is registered.

While medical examiner data is used to complete the death certificate, it is important to realize that it is not the same dataset and it may yield slightly different statistics for several reasons*. Bearing this in mind, the case definition for drug-related deaths in this report considers two aspects:

1. **Pathologist description of the cause and manner of death**: Our dataset does not include the official death certificate, and so we use a combination of available fields in our case management system combined with manual review. The pathologist completing the autopsy or record review is able to select from a list of category options describing the cause of death; several of these options describe the case as a 'drug death.' Additionally, the pathologist completes a field describing how injury occurred. Finally, although it is not the official cause of record, we are able to view the cause and manner of death stated by the pathologist on the autopsy report.
   Our process is to identify all cases where one or more of the following is true: (1) The category of the cause of death selected by the pathologist is a 'drug death' option, (2) The injury is described as being due to taking or being exposed to one or more drugs, or (3) The cause of death listed on the autopsy report is drug toxicity. After identifying these cases using an automated search algorithm, they are manually reviewed to verify that the classification is accurate.
   As part of this review process, we exclude all drug-related deaths with a *natural* manner. Deaths due to chronic drug abuse are assigned a natural manner, as opposed to deaths due to acute drug toxicity, which will have a non-natural manner. Because this report is focused on the latter category of drug-related deaths, we choose to exclude chronic abuse deaths here.

2. **Location of death**: The deaths investigated by WLJFC necessarily occurred within our service region, and so our discussion of drug-related deaths is restricted to cases where the decedent died in one of the eight counties listed in the previous section. This is important to establish because most public health datasets are based on residency (i.e., where the decedent lived), but this report is based on occurrence (i.e., where the death occurred). The drug-related death counts presented in this report may therefore differ from other public health sources. There are also additional statistical caveats regarding rate calculation, as discussed in the next section.

Using this case definition, we have identified 725 drug-related deaths investigated by WLJFC between 2022 and 2024.

* See Appendix A for a more detailed description of the discrepancies that can occur between ME datasets and death certificate registries

Analysis Methodology

Statistics in this report are presented in three ways:

- *Count data*: the number of decedents in the category of interest
- *Percentage data*: the percentage of decedents grouped by a demographic or year
- *Crude rate data*: the number of deaths per 100,000 residents in a particular geographic or demographic group

Rates are often preferred in public health data, as they allow comparisons between groups more effectively when there are differences in population sizes. This is particularly useful when studying smaller populations, when it can be difficult to get a sense of the impact of a problem from counts alone. To calculate a rate, the count is divided by the population of interest. This rate is then commonly multiplied by 100,000, so what is presented is actually a "rate per 100,000." For example, if a rate is reported as 14.3, that really means that for every 100,000 people in the population of interest, 14.3 are affected by the problem.

There is a robust body of literature on the calculation of mortality rates in particular because of the question of how to determine the population that one uses as the denominator in the above equation. It is not the goal of this report to summarize this complexity, but we note it because our case count being based on occurrence as described in the previous section presents an additional layer of complexity in population definitions that must be addressed.

In large-scale mortality statistics, it is standard practice to use the US census population estimate in calculating rates. This is partially why public health datasets collect based on residency; if one has counted the number of residents impacted by a disease in a certain demographic, then using census estimates to calculate a rate makes logical sense. But our case definition collects cases based on death location, meaning that we don't have a full resident count – if a resident of a TN county within WLJFC's service area died due to drug overdose outside of our service area (across the state line in Virginia, for example), their death was not reported to the forensic center and therefore will not be included in our counts. Additionally, WLJFC investigates all deaths occurring within our service area, regardless of residency, so our counts will include out-of-region residents.

For this report, we have chosen to include all decedents in our rate calculations and also to use the standard census estimates for the denominators. This allows us to compare mortality rates within our dataset itself, especially as we continue to report statistics in future years.

Finally, we note that some demographics contain counts of 20 or fewer. While we do not suppress small counts in WLJFC reporting, counts less than 20 can be challenging to interpret due to the associated large standard errors. Essentially, when counts are small, even expected minor fluctuations look statistically more important than they are. In general, it is never recommended to calculate rates for counts less than 10, and rates for counts less than 20 should be interpreted with extreme caution.

Because the issue of small counts can impact rate calculations more than other statistics in this report, we have chosen to present 95% confidence intervals beside all rates shown in tables. A confidence interval (CI) is a good way of understanding the uncertainty present in a calculation; the wider the CI, the less accurate that rate likely is. If two confidence intervals overlap, then there is no statistical difference between the two values, which can be helpful for understanding when a change is significant or not.

II. Characteristics of Drug-Related Deaths by Region

From 2022 to 2024, there were 725 drug-related deaths reported to WLJFC according to the case definition discussed in Section I. Across these years, statistical death data provided by the Tennessee Vital Statistics division at the TN Department of Health states that there have been 25,956 deaths in the eight service counties. Thus, drug-related deaths account for 2.8% of total deaths in the region.

Bearing in mind that drug-related deaths cannot have a natural manner, it is also meaningful to note that in these years, there have been 2,340 deaths that were not assigned a natural manner of death; drug-related deaths therefore account for 31.0% of deaths with a manner of death other than natural. Using the latest population estimates provided by the US Census Bureau, we also calculate that the mortality rate for drug-related deaths from 2022 to 2024 in our service region was 45.5 deaths per 100,000 residents.

Table 2.1shows the rates and percentages of drug-related deaths for each county. We group counties by jurisdiction because WLJFC performs multiple services for jurisdictional counties; for non-jurisdictional counties, with some exceptions, WLJFC predominantly provides autopsy services only, which has the potential to impact the case counts.

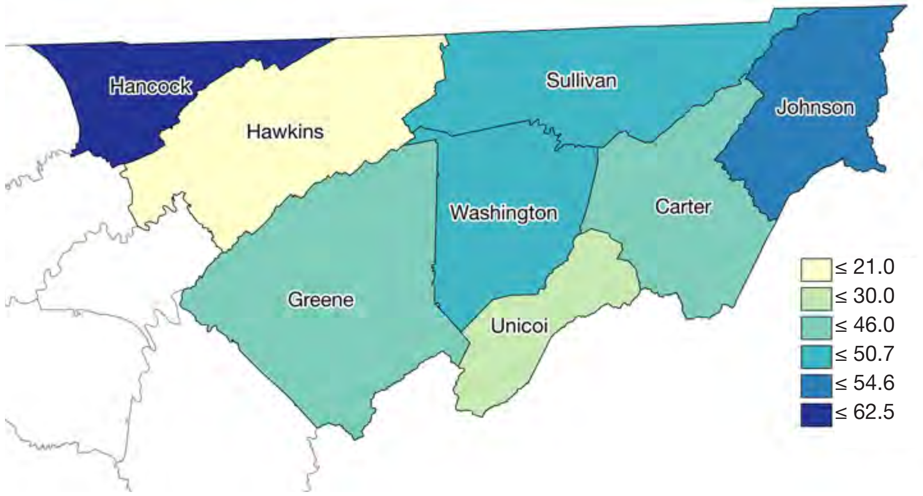
Table 2.1 Drug-Related Mortality Rates by County, 2022-2024 (N = 725)

	Number of Drug-Related Deaths	Percentage of County Deaths	Mortality Rate Per 100,000 Residents*	95% CI
Jurisdictional Counties				
Carter	74	3.6	43.3	34.0 - 54.4
Johnson	30	5.8	54.6	36.8 - 77.9
Unicoi	16	2.3	30.0	17.2 - 48.8
Washington	209	2.7	50.5	43.8 - 57.8
Non-Jurisdictional Counties				
Greene	100	3.7	46.0	37.4 - 56.0
Hancock	13	5.3	62.5	33.3 - 106.9
Hawkins	37	2.1	21.0	14.8 - 29.0
Sullivan	246	2.4	50.7	44.5 - 57.4
Total	725	2.8	45.5	42.3 - 48.9

*Rates calculated by dividing the drug-related death count by county population and multiplying result by 100,000

We can see some variation in the percentage of deaths that are drug-related in each county, but the rate calculation gives us a stronger sense of what that variation means. Hawkins County has the lowest rate of drug-related mortality at 21.0 deaths per 100,000 residents, and while the highest rate is technically in Hancock County, at 62.5 deaths per 100,000 residents, we can see that this rate is actually very unstable. The total number of drug-related deaths in Hancock is quite low, meaning that there is a lot of error associated with this rate; the confidence interval for this rate is very wide compared to the other counties. The county with the next highest rate, Johnson County at 54.6 deaths per 100,000 residents, is more stable. For a visual comparison, Map 2.1 shows the drug-related mortality rate of each county.

Map 2.1 Drug-Related Mortality Rate by County, 2022-2024 (N = 725)

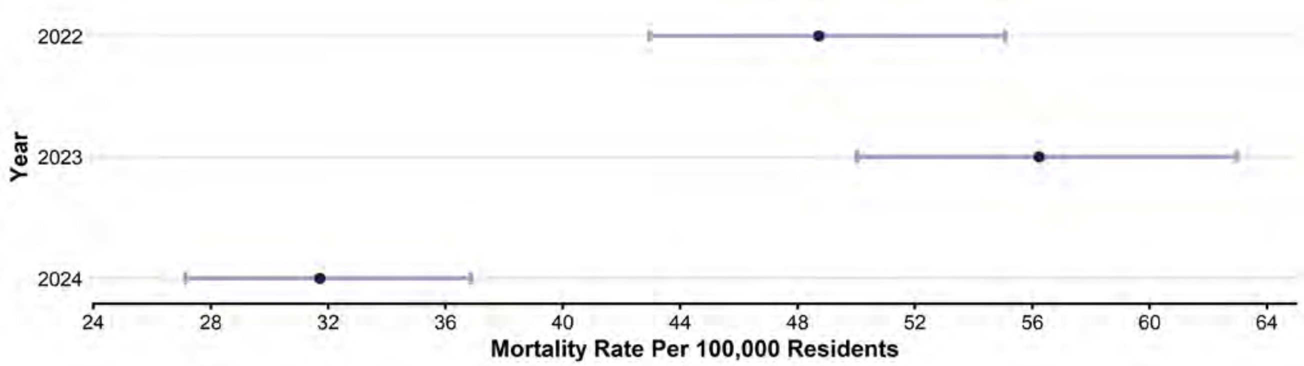


While we have presented statistics aggregated across all data years in the previous table, it is important to note that there have been significant changes in the number of drug-related deaths in this timeframe. Specifically, in 2024, there were almost half as many drug-related deaths than in previous years. We expect a certain amount of fluctuation in the number of deaths due to any mechanism from year to year, but a decrease this substantial is likely to be statistically significant.

In Figure 2.1, we use rates with confidence intervals to illustrate this significance. The light blue bars on the figure represent the 95% confidence interval associated with each yearly rate; we can see that in 2022 and 2023, the bars have substantial overlap. This means that between 2022 and 2023, while the calculated rates are slightly different, we cannot conclude that the difference is statistically significant.

But the bars associated with the 2024 rate on the bottom line do not overlap with either previous year. This means that the rate of drug-related deaths in 2024 is statistically lower than previous data years.

Figure 2.1 Drug-Related Mortality Rate by Year, 2022-2024 (N = 725)



Despite this difference, we will aggregate data across years for the majority of this report; this enables us to look at statistics associated with small counts, which would have to be suppressed in any single data year. When appropriate, we will discuss trends across data years so that this difference can be further explored.

About ninety-five percent (95.4%) of drug-related deaths from 2022 to 2024 were accidental, as shown in Fig 2.2. The corresponding Table 2.2 shows the yearly breakdown of drug-related deaths by manner; there is no substantial change in proportion over time. In any year, the majority of drug-related deaths were accidental, with a much smaller percentage of deaths due to suicide or undetermined intent. As stated in Section I, drug-related deaths classified as natural manner are always cases where the decedent dies due to chronic abuse and are beyond the scope of this report.

Figure 2.2 Drug-Related Deaths by Manner, 2022-2024 (N = 725)

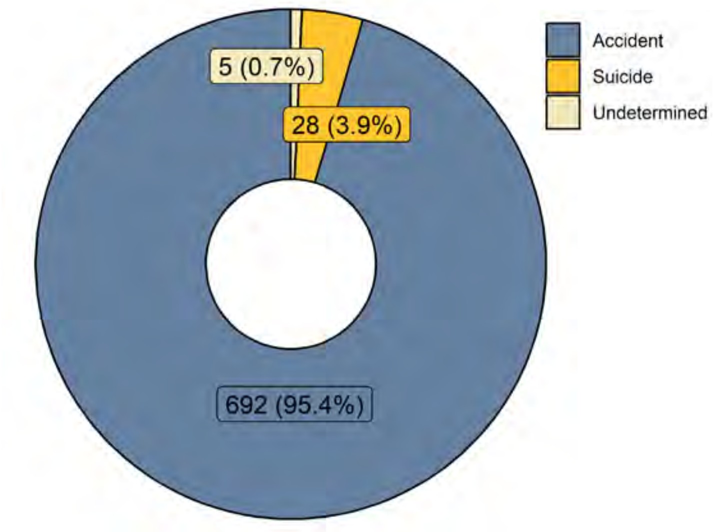


Table 2.2 Drug-Related Deaths by Manner by Year, 2022-2024 (N = 725)

	2022		2023		2024		Total	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Accident	241	94.1	286	95.7	165	97.1	692	95.4
Suicide	11	4.3	12	4.0	5	2.9	28	3.9
Undetermined	4	1.6	1	0.3	0	0	5	0.7
Total	256		299		170		725	

From the counts of drug-related deaths by county in Table 2.1, we can see that a slight majority of deaths (396 cases, 54.6%) occurred in non-jurisdictional counties compared to jurisdictional counties (329 cases, 45.4%). Table 2.3 on the next page examines these counts by activity completed by WLJFC. Jurisdiction was accepted by the ME's office for all drug-related deaths, but there is some variation in the type of autopsy ordered (full, external, or limited), and in 2022, two cases were accepted for record review.

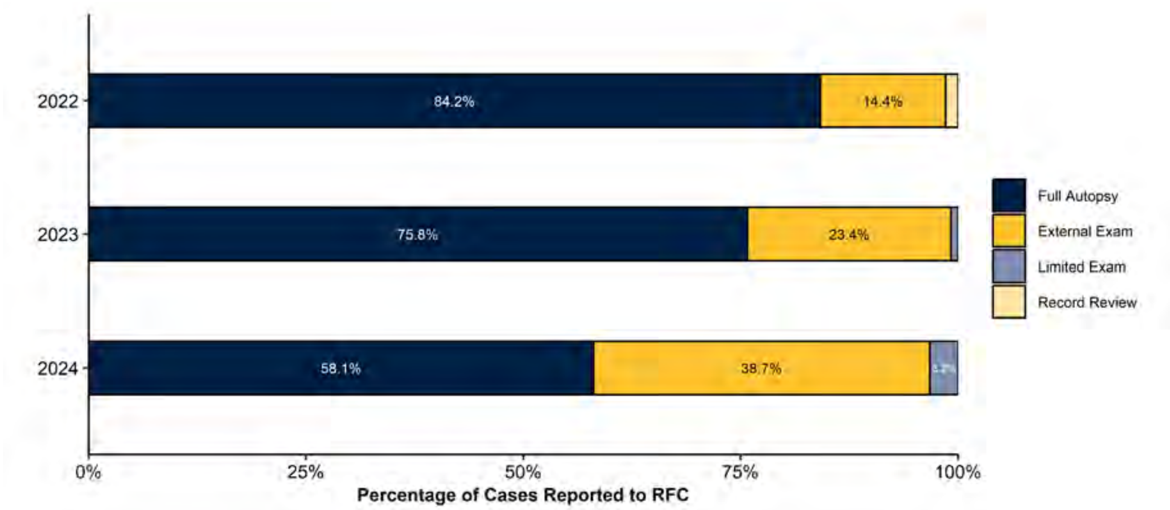
Fig 2.3 compares the percentage distribution of these activities by year; part (a) shows the breakdowns for jurisdictional counties, and part (b) shows non-jurisdictional counties.

Table 2.3 Activities Completed by WLJFC by County, 2022-2024 (N = 725)

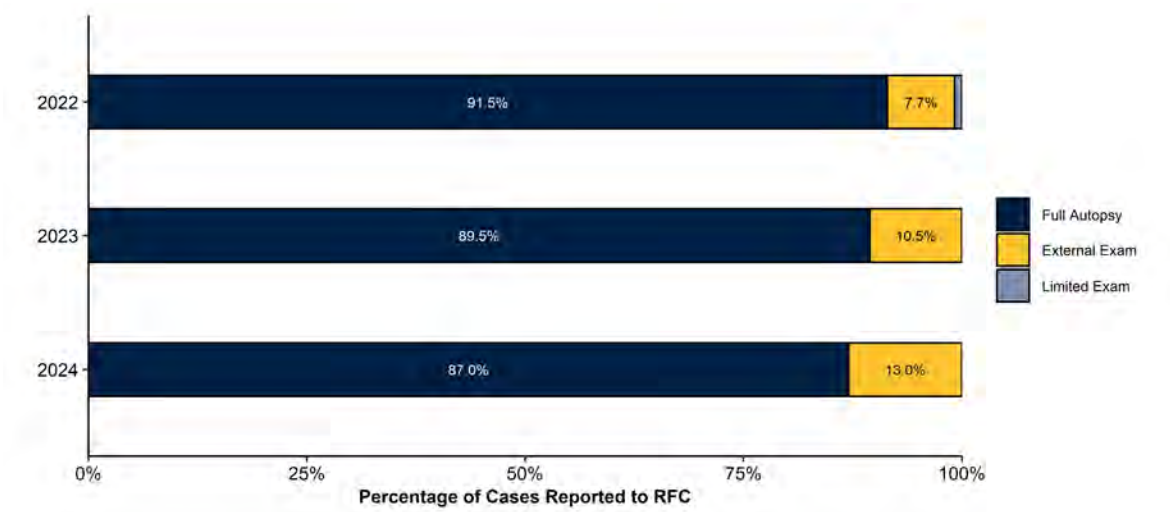
	Full Autopsy	External Exam	Limited Exam	Record Review	Total Deaths
Jurisdictional Counties					
Carter	55	18	1	0	74
Johnson	23	7	0	0	30
Unicoi	12	3	1	0	16
Washington	160	46	1	2	209
Non-Jurisdictional Counties					
Greene	95	4	1	*	100
Hancock	12	1	0	*	13
Hawkins	27	10	0	*	37
Sullivan	220	26	0	*	246
Total	604	115	4	2	725

Figure 2.3 Activities Completed for Drug-Related Deaths, 2022-2024

(a) Jurisdictional County Activities by Year (N = 329)



(b) Non-Jurisdictional County Activities by Year (N = 396)



We now turn our attention to the demographics (sex, race/ethnicity, age) of drug-related cases. The percentage breakdowns by year are shown in Table 2.4. We can see that while the total case counts fluctuate each year, the percentage distributions are very similar. The majority of decedents are male, white, and non-Hispanic. The highest percentage of decedents in each year are either between 45 and 54 years old at time of death, or between 35 and 44 years.

Table 2.4 Drug-Related Death Demographics by Year, 2022-2024 (N = 725)

	2022		2023		2024	
	Count	Percent	Count	Percent	Count	Percent
Sex						
Male	176	68.8	194	64.9	103	60.6
Female	80	31.3	105	35.1	67	39.4
Race						
White	235	91.8	282	94.3	159	93.5
Black	19	7.4	16	5.4	10	5.9
Other*	2	0.8	1	0.3	1	0.6
Ethnicity						
Not Hispanic	253	98.8	297	99.3	170	100.0
Hispanic	3	1.2	2	0.7	0	0.0
Age at Death						
Below 18 years	3	1.2	1	0.3	0	0.0
18-24 years	16	6.3	19	6.4	9	5.3
25-34 years	49	19.1	50	16.7	27	15.9
35-44 years	59	23.0	86	28.8	39	22.9
45-54 years	67	26.2	68	22.7	46	27.1
55-64 years	44	17.2	48	16.1	34	20.0
65+ years	18	7.0	27	9.0	15	8.8

*Aggregated category includes Asian and unspecified Other racial classifications

Fig 2.4 shows the mortality rate distribution by age by year*; we can see that for all age groups excepting 35-44 years, the rates in 2022 and 2023 were comparable. For 2024, the rate is lower overall, but we also see a slight shift in age; the peak of the 2024 distribution is at 45-54 years. This shift is not statistically significant, however.

To explore this potential trend, we calculated the average age at death in each year, and even though that average is higher in 2024 (46.5 years) compared to the previous ones (2022: 44.5 years, 2023: 44.8 years), the confidence intervals associated with each calculation overlap, meaning that we cannot conclude a significant difference.

---

* Rate calculations suppressed for all counts less than 10; rates associated with counts less than 20 should be interpreted with caution

Figure 2.4 Drug-Related Mortality Rates by Age at Death by Year, 2022-2024 (N = 725)

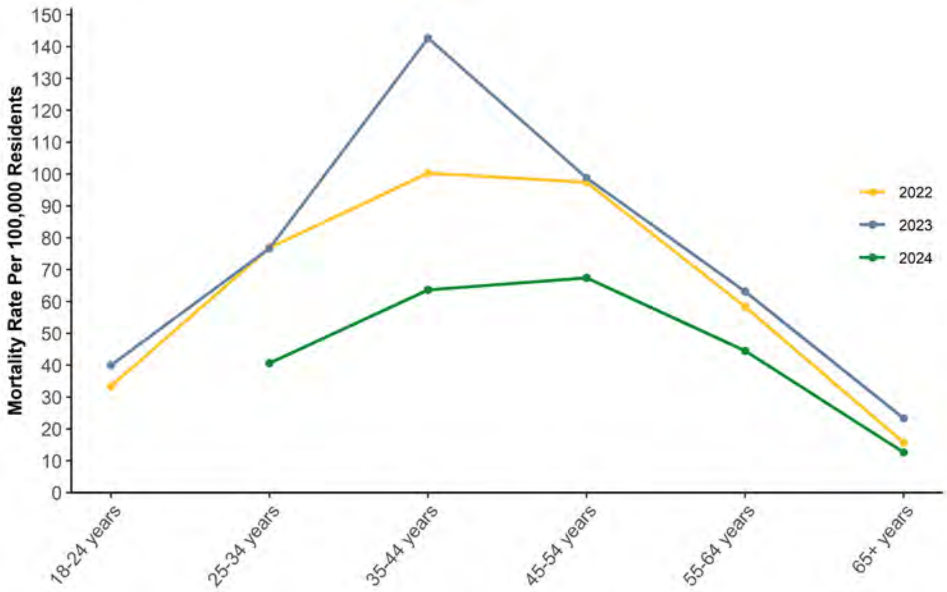


Table 2.5 shows aggregated rate calculations for all demographics; as in other tables, rates are not calculated for any count fewer than 10. The mortality rate was 1.9 times higher for males than females (60.1 deaths per 100,000 compared to 31.3 deaths per 100,000). The mortality rate was 2.3 times higher for black decedents than white decedents (102.6 deaths per 100,000 compared to 45.2 deaths per 100,000), despite the overall percentage of drug-related deaths being higher for white decedents. These groupings include Hispanic white and Hispanic black decedents respectively due to the available population groups for rate calculation. We also see that the highest mortality rate by age was among decedents aged between 35 and 44 years at time of death.

Table 2.5 Drug-Related Mortality Rates by Demographic, 2022-2024 (N = 725)

	Count	Percent	Rate Per 100,000 Residents	95% CI
Sex				
Male	473	65.2	60.1	54.8 - 65.7
Female	252	34.8	31.3	27.5 - 35.4
Race				
White	676	93.2	45.2	41.9 - 48.7
Black	45	6.2	102.6	74.8 - 137.3
Other*	4	0.6	*	*
Ethnicity				
Not Hispanic	720	99.3	*	*
Hispanic	5	0.7		*
Age at Death				
Below 18 years	4	0.6	*	*
18-24 years	44	6.1	30.8	22.4 - 41.4
25-34 years	126	17.4	64.5	53.8 - 76.8
35-44 years	184	25.4	102.0	87.8 - 117.9
45-54 years	181	25.0	88.0	75.6 - 101.7
55-64 years	126	17.4	55.3	46.1 - 65.9
65+ years	60	8.3	17.2	13.2 - 22.2

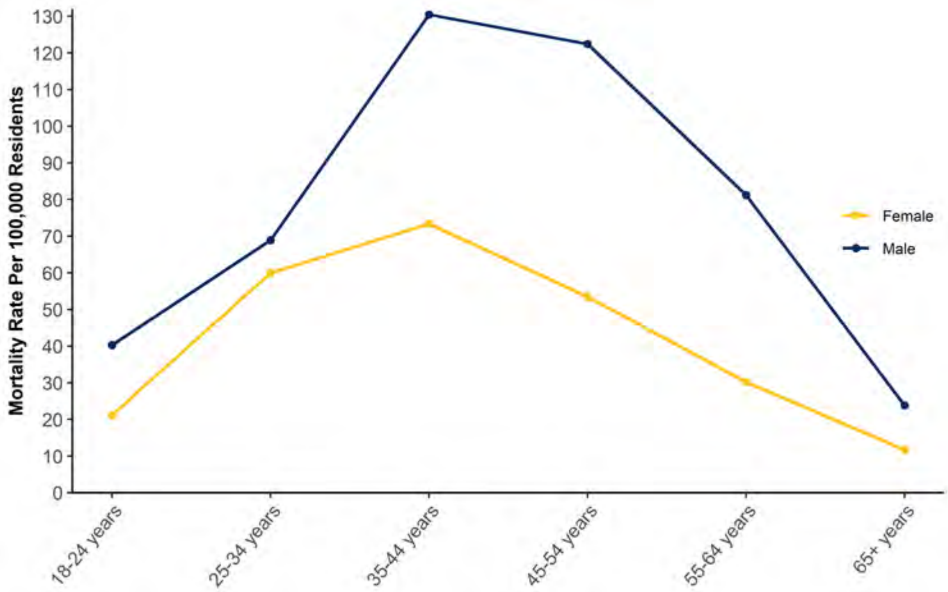
*Aggregated category includes Asian and unspecified Other racial classifications

Fig 2.5 shows the mortality rate distribution by age by sex; we can see some suggestion that the distribution is different for male decedents compared to female decedents. While the highest mortality rate for both male and female decedents occurs between 35 and 44 years, the shape of the male distribution is skewed toward the older age groups, while the female distribution appears to skew slightly toward the younger age groups.

To explore the potential visual differences in this figure, we conduct additional statistical testing. While the average age at death for male decedents is slightly higher, as expected: 45.8 years compared to 43.8 years for female decedents, this difference is not statistically significant in our dataset. As defined previously in this report, the 95% confidence intervals associated with these calculations overlap.

We conducted additional testing to compare the overall distribution shapes as opposed to just the averages, and without going into the specifics of a complete statistical analysis, we have found preliminary evidence to suggest that there are significant distributional differences in age at death by sex among drug-related deaths, but more data years are necessary to confirm. In practical terms, what this means is that what we're seeing here is that female decedents who die due to drug-related injury tend to be somewhat younger at time of death than male decedents.

Figure 2.5 Drug-Related Mortality Rates by Age at Death by Sex, 2022-2024 (N = 725)



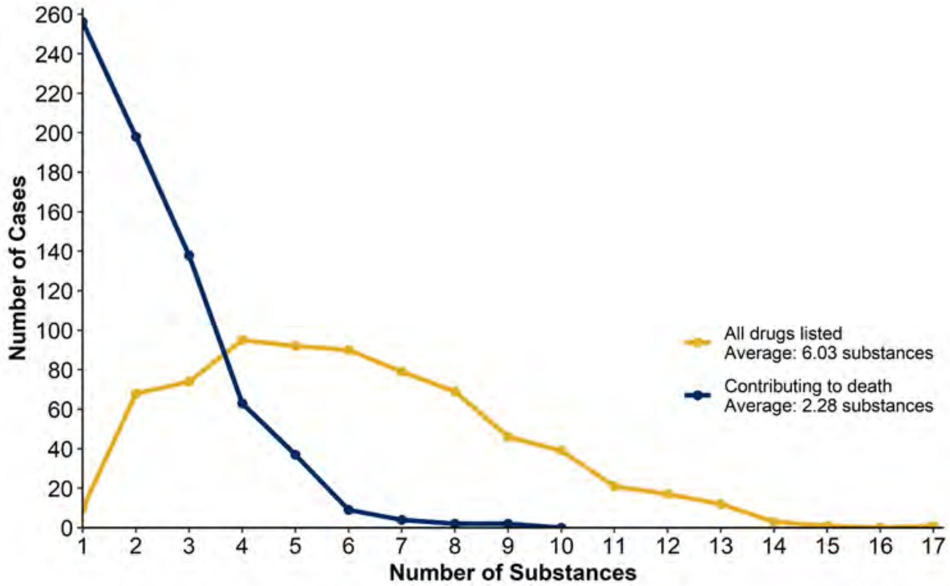
We now turn our attention to the toxicology information available for drug-related deaths. Manual review shows that seven decedents did not have toxicology testing due to a long period of hospitalization prior to death. For the remainder of this section, we have excluded these cases and will only consider toxicology information for 718 cases.

Further, we excluded substances related to the 1919FL Electrolytes and Glucose Panel (Vitreous) that is sometimes ordered. These results should not contribute to any count that is meant to represent the number of ingested substances and/or metabolites of ingested substances, so these were excluded from any analysis. Similarly, we excluded positive results for caffeine, cotinine, and nicotine. These are not controlled substances and they are almost never present at potentially toxic levels, so our analysis again considers these extraneous substances and excludes them.

Figure 2.6 shows the distribution of the number of positive substances on the toxicology results for the 718 cases with available information. The blue line shows the count for all present substances, except for the exclusions mentioned above. We remind the reader that metabolites show up as distinct from the substance the decedent took. For example, depending on the time the drug spent in the system prior to death, a person taking illicit fentanyl may test positive for 1) fentanyl alone, 2) fentanyl and norfentanyl, 3) fentanyl and 4-ANPP, 4) fentanyl, norfentanyl, and 4-ANPP. This may be further impacted by residual metabolites of substances taken on a chronic basis.

Because of this, we also show the number of substances indicated as contributing to death as the yellow line, which assumes that the pathologist has interpreted the toxicology results to indicate the actual substances ingested. In some cases, a metabolite is endorsed as contributing to death when the original substance has already been fully metabolized. For example, if a decedent is positive for benzoylecognine, but the original cocaine is not present, the pathologist may endorse benzoylecognine as contributing to death but write 'cocaine' on the certificate. If both cocaine and benzoylecognine are present, the expectation would be that only cocaine would be endorsed as contributing.

Figure 2.6 Number of Substances Present on Toxicology, 2022-2024 (N = 718)



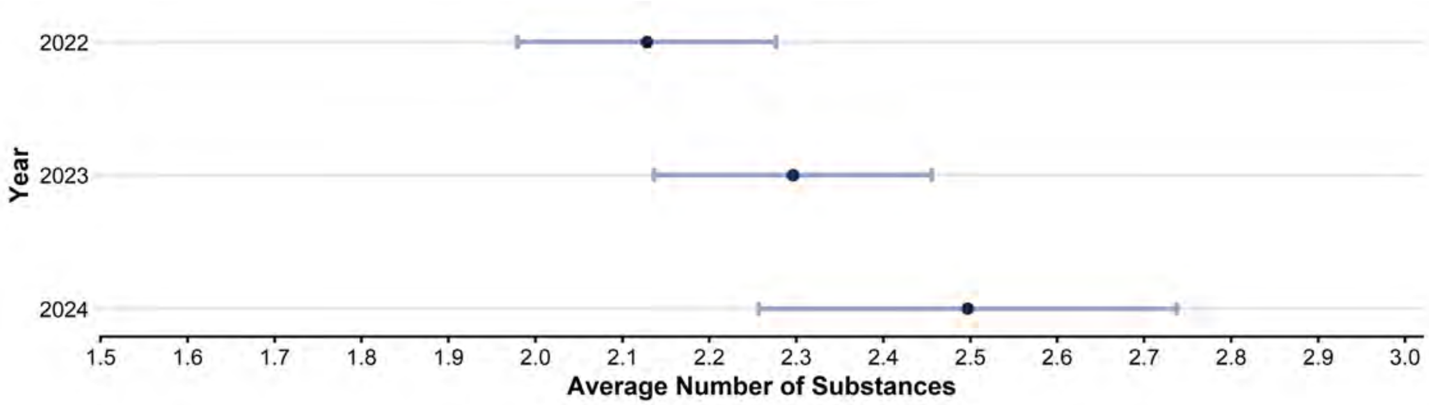
We note here that an additional nine cases had no substances indicated as contributing to death. In all of these cases, the substance contributing to death was present on toxicology, but the case management software did not indicate that it was a contributing substance for unknown reasons.

We can see in Figure 2.6 above that the number of drugs showing positive (average number is 6.03 substances) is much higher on average than the number of drugs listed as contributing to death (average number is 2.28 substances). Given the discussion on metabolites, this result is not surprising.

Several statistical tests were conducted to verify any potential trends in these counts by year. We saw no change in the number of substances present per decedent overall, but we saw an increase in the number of substances indicated as contributing to death. As mentioned previously, we will not present the specifics of the analysis in this report, but we found evidence that there are some statistically significant differences in the distribution of the number of substances contributing to death from 2022 to 2024.

Fig 2.7 below shows the average number of substances contributing to death by year, with 95% confidence intervals to aid comparison. We can see that the intervals overlap for all years, meaning that the difference in mean cannot be determined to be statistically significant, but we also see that the degree of overlap decreases each year. This fluctuation is what the additional statistical testing indicates is potentially interesting. We need to collect additional data years to have a more complete understanding of this trend.

Fig 2.7 Average Number of Substances Contributing to Death by Year, 2022-2024 (N = 718)



In the remainder of this section, we will look at specific substances found in drug-related deaths. Table 2.6 below shows the yearly percentages of deaths per year where substances of common interest were listed as contributing to death. The nine cases where the case management system did not indicate any substances were manually abstracted by reading the causes of death and adjusting the yearly counts appropriately.

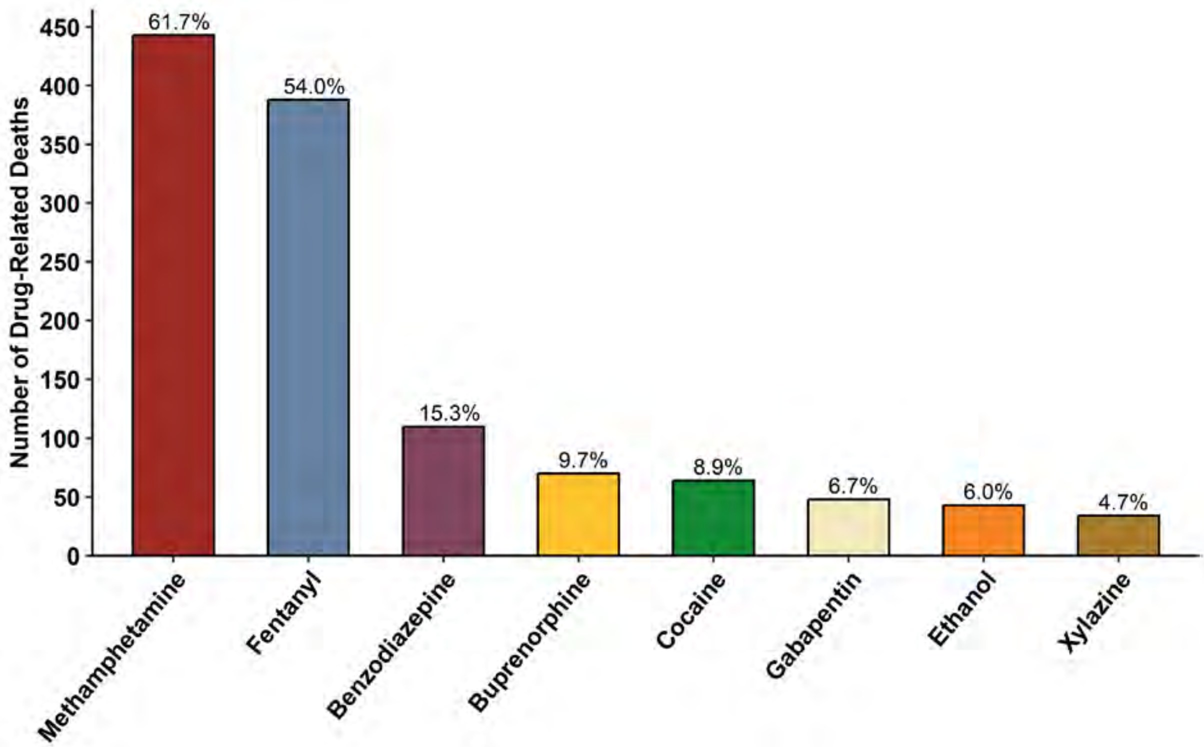
Table 2.6 Common Substances Contributing to Drug-Related Deaths by Year, 2022-2024 (N = 718)

	2022		2023		2024	
	Count	Percent	Count	Percent	Count	Percent
Methamphetamine						
Yes	154	60.9	179	60.3	110	65.5
No	99	39.1	118	39.7	58	34.5
Fentanyl						
Yes	146	57.7	160	53.9	82	48.8
No	107	42.3	137	46.1	86	51.2
Benzodiazepine						
Yes	30	11.9	47	15.8	33	19.6
No	223	88.1	250	84.2	135	80.4
Cocaine						
Yes	22	8.7	24	8.1	18	10.7
No	231	91.3	273	91.9	150	89.3
Buprenorphine						
Yes	19	7.5	35	11.8	16	9.5
No	234	92.5	262	88.2	152	90.5
Ethanol						
Yes	18	7.1	16	5.4	9	5.4
No	235	92.9	281	94.6	159	94.6

Before discussing specific trends, it should be noted that decedents who had positive toxicology for multiple substances are included in all relevant group counts. For example, someone who was positive for both fentanyl and methamphetamine would be included in each appropriate row on Table 2.6.

Fig 2.8 shows the total percentages of common substances contributing to death across all data years; this figure includes two substances not shown in Table 2.6 (gabapentin and xylazine). These substances are shown here because at the time of writing, they are of interest in the broader literature of drug-related mortality research. Since they are not present in drug-related deaths investigated by WLJFC in high counts, we show these percentages here for completeness.

Figure 2.8 Common Substances Contributing to Drug-Related Deaths, 2022-2024 (N = 718)

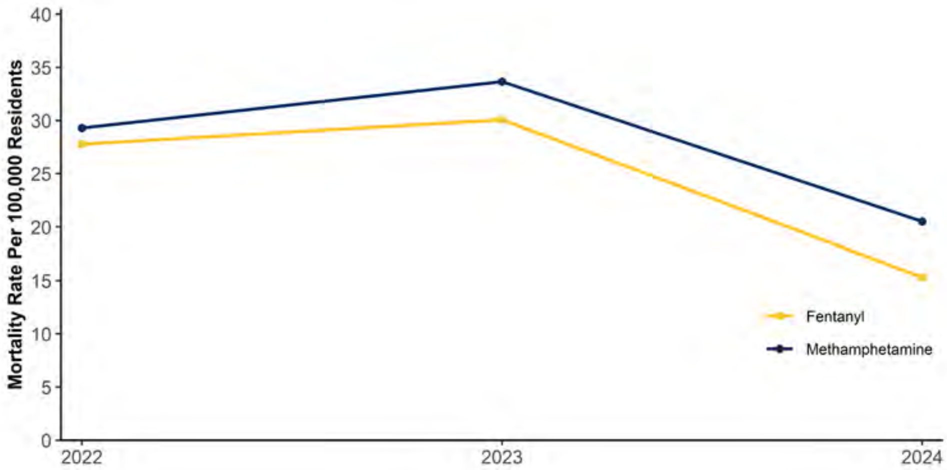


In all data years, the most common substance contributing to death was methamphetamine, which was listed as contributing in 61.7% of all drug-related deaths in our dataset. Fentanyl was also listed as contributing in a slight majority (54.0%) of all drug-related deaths. No other single substance was indicated as contributing in more than ten percent of drug-related deaths; while benzodiazepines were indicated in 15.3% of deaths, that is a category of multiple substances.

While Table 2.6 shows how the percentage of substances contributing to death varies across data years, it is useful to consider how the rate varies as well. Since rates have associated confidence intervals, they can be a more accurate way to discuss changes compared to percentages because there is a statistical standard we can apply. We tabulated yearly rates for all substances shown in Table 2.6, and we found that with the exception of the two most common substances (methamphetamine and fentanyl), the rates of deaths involving all other drugs were not statistically different across our data years.

Fig 2.9 shows the change in mortality rate for both fentanyl-involved and methamphetamine-involved deaths from 2022 to 2024. We can see that the rates decrease substantially in 2024, but we also see that the fentanyl-involved mortality rate decreases more compared to the methamphetamine-involved rate. In fact, when looking at 95% confidence intervals, the fentanyl-involved mortality rate in 2024 is significantly different than both prior years by a comfortable margin. But if we run the same comparison using the confidence intervals of the methamphetamine-involved mortality rate, the top of the 2024 interval just barely intersects with the bottom of the 2022 interval; this means that we cannot as easily conclude that the decrease in rate is statistically significant. We look forward to conducting additional analyses on these trends when more data years are available.

Figure 2.9 Mortality Rates by Contributing Drug by Year, 2022-2024 (N = 718)



When considering a more complete list of contributing substance, it is helpful to distinguish between single-drug deaths, where one substance was listed as contributing to death, and polydrug deaths, where two or more substances were listed as contributing to death. The majority of drug-related deaths (63.2%) are polydrug; this percentage has changed slightly from 2022 to 2024, but it is not a significant increase in this timeframe.

Tables 2.7(a) and (b) on the next page provide a complete list of contributing substances in single-drug deaths, and a list of contributing substances for five or more decedents in polydrug deaths, truncating for readability.

The majority of single-drug deaths were due to methamphetamine (61.4%), with the second-most common substance being fentanyl (20.1%), followed by cocaine (5.3%). The remainder of substances contributing to single-drug deaths had very small counts.

In polydrug deaths, the fact that multiple substances are associated with a single decedent can make interpreting counts more complex. Despite this, we can see that the most common substance present in polydrug deaths was fentanyl (73.6%), followed by methamphetamine (61.9%). We also note that several substances listed in this table, including 4-ANPP, para-fluorofentanyl, and acetyl fentanyl, are either fentanyl analogs or precursors.

Due to the prevalence of fentanyl and methamphetamine in polydrug deaths, we also calculated the number of decedents where both these substances were present. We found that both fentanyl and methamphetamine were listed as contributing to death in 219 (48.2%) of the total 454 polydrug deaths. No other substances in this table were present in as substantial a percentage as either fentanyl or methamphetamine.

Table 2.7 Substances Contributing to Death in Drug-Related Deaths, 2022-2024 (N = 718)

(a) Single-Drug Deaths		
	Count	Percent
Methamphetamine	162	61.4
Fentanyl	53	20.1
Cocaine	14	5.3
Oxycodone	4	1.5
Ethanol	3	1.1
Methadone	3	1.1
Acetaminophen	2	0.8
Benzoylecgonine	2	0.8
Bromazolam	2	0.8
Mitragynine	2	0.8
Morphine	2	0.8
Oxymorphone	2	0.8
Amitriptyline	1	0.4
Buprenorphine	1	0.4
Bupropion	1	0.4
Clonidine	1	0.4
Cyclobenzaprine	1	0.4
Diphenhydramine	1	0.4
Gabapentin	1	0.4
Hydrocodone	1	0.4
Memantine	1	0.4
Methanol	1	0.4
Mirtazapine	1	0.4
Sodium nitrate	1	0.4
Venlafaxine	1	0.4
Total Number of Decedents	264	

(b) Polydrug Deaths		
	Count	Percent
Fentanyl	334	73.6
Methamphetamine	281	61.9
Buprenorphine	67	14.8
Alprazolam	53	11.7
Gabapentin	48	10.6
Cocaine	46	10.1
4-ANPP	41	9.0
Ethanol	40	8.8
Oxycodone	37	8.1
Xylazine	34	7.5
Diphenhydramine	27	5.9
para-Fluorofentanyl	27	5.9
Hydrocodone	24	5.3
Clonazepam	19	4.2
Promethazine	18	4.0
Diazepam	16	3.5
Hydroxyzine	15	3.3
Acetyl Fentanyl	13	2.9
Bromazolam	13	2.9
Mitragynine	13	2.9
Morphine	13	2.9
6-Monoacetylmorphine	11	2.4
7-Amino Clonazepam	9	2.0
Methadone	9	2.0
Acetaminophen	8	1.8
Cyclobenzaprine	8	1.8
Amitriptyline	7	1.5
Amphetamine	7	1.5
Bupropion	7	1.5
Duloxetine	6	1.3
Nordiazepam	6	1.3
Oxymorphone	6	1.3
Trazodone	6	1.3
Total Number of Decedents	454	

III. Characteristics of Drug-Related Deaths by County

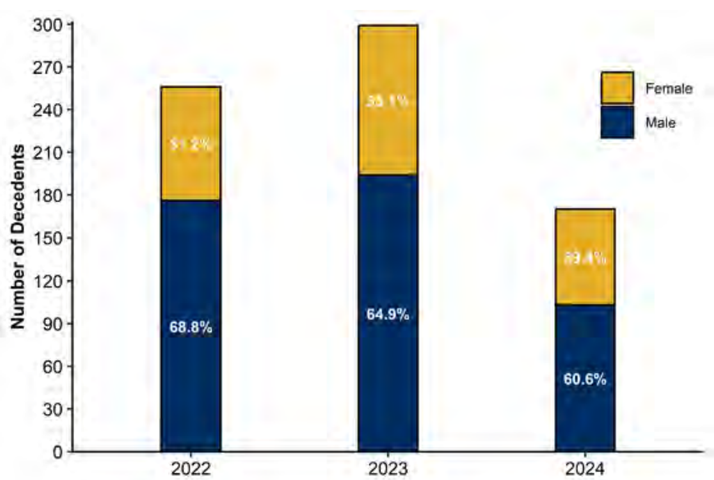
In this section, we will consider the characteristics of drug-related deaths as they vary by county of death. We have chosen to format this discussion as a series of county-specific "fact sheets," so that data partners interested in either county comparison or in single-county details can use these pages as separate documents if desired.

Below are some key findings summarized from Section II to more easily aid comparison, formatted to match the presentation of the following fact sheets.

Drug-Related Death Demographics

- There were 725 drug-related deaths reported to WLJFC from 2022 to 2024, accounting for 2.8% of all deaths
- The total drug-related mortality rate was 45.5 deaths per 100,000 residents, and it decreased significantly in 2024 compared to previous years
- 95.4% of drug-related deaths were accidental in manner
- 93.2% of decedents were white, non-Hispanic
- Very similar percentages of decedents were either in the age range of 35-44 years (25.4%) or 45-54 years (25.0%); there is substantial discussion of average age at death for all decedents in Section II of this report

Drug-Related Decedent Sex by Year



Overall, 65.2% of all drug-related deaths from 2022 to 2024 were male, and 34.8% were female. We see a slight variation in these proportions by year, as shown in the accompanying figure, but this yearly difference is not statistically significant.

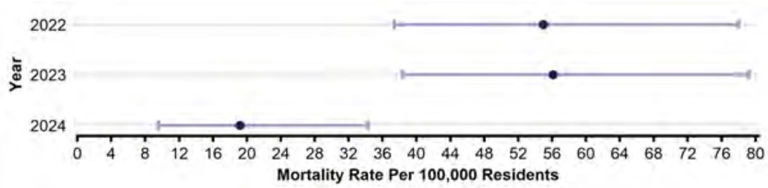
Drug-Related Death Characteristics

- An average of 6.03 substances were detected per decedent; an average of 2.28 substances were listed as contributing to death
- The majority of drug-related deaths (454 cases, 63.2%) were polydrug overdoses; the remaining 264 cases (36.8%) were single-drug overdoses
- There was not substantial variation in the percentage of deaths involving specific substances by year; in all years, the most common substance was methamphetamine, followed by fentanyl
- About a third (30.2%) of all drug-related deaths involved both fentanyl and methamphetamine

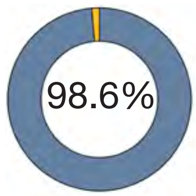
Drug-Related Deaths | 2022-2024

From 2022 to 2024, there were 74 drug-related deaths in Carter County reported to WLJFC, accounting for 3.6% of all deaths. The total drug-related mortality rate in this time was 43.3 deaths per 100,000 residents, but there was a dramatic decrease in the mortality rate in 2024, dropping to 19.2 deaths per 100,000 residents. This decrease was statistically significant.

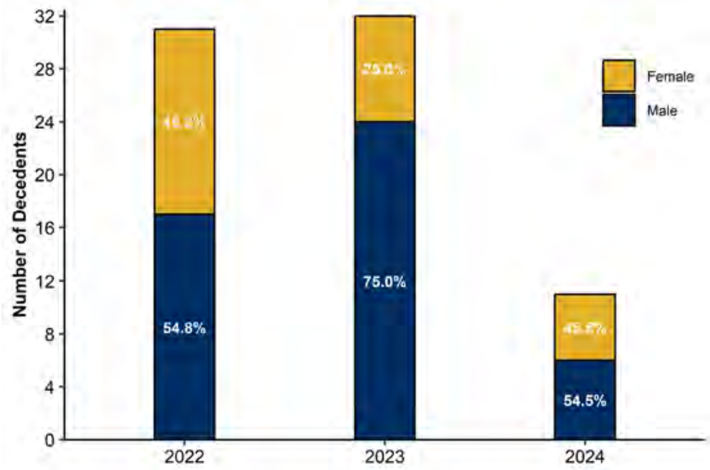
Drug-Related Mortality Rate by Year



Most drug-related deaths were accidental in manner



Drug-Related Decedent Sex by Year



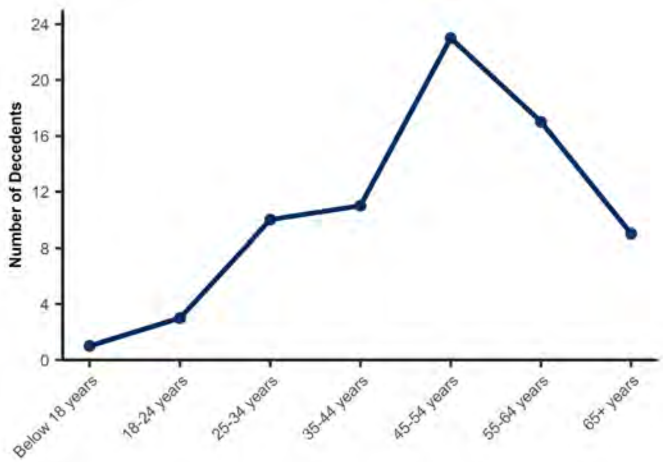
Overall, 63.5% of drug-related deaths in Carter County from 2022 to 2024 were male, and 36.4% were female. We see some variation in these proportions by year, as shown in the accompanying figure. In all years, the majority of decedents were male, but in 2023 that majority was a much higher percentage than in 2022 or 2024.

All decedents were white, non-Hispanic

The yearly counts are too small to present age groups separately, so we aggregate across years. We also present counts instead of rates due to small numbers in each age group.

The largest percentage (31.1%) of decedents are age 45 to 54. The average age at death overall was 48.6 years old. Male decedents had a higher average age compared to female decedents: 50.3 years for males and 45.7 years for females. Small counts mean that this difference is not statistically significant.

Drug-Related Decedent Age

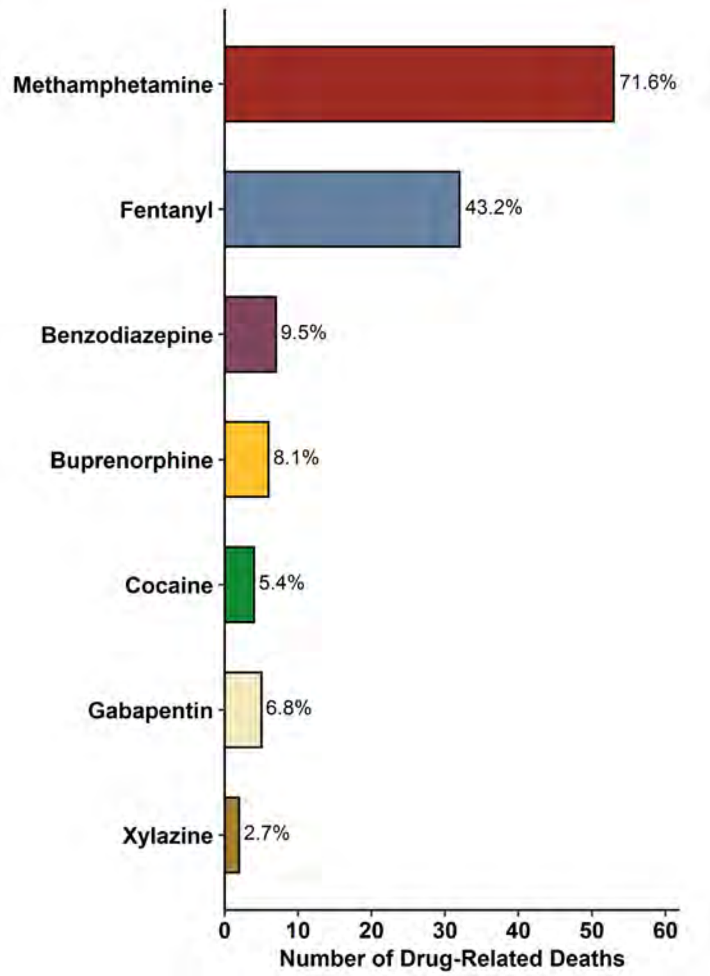


Drug-Related Deaths | 2022-2024

Drug-Related Death Characteristics

- An average of 5.84 substances were detected per decedent; an average of 2.07 substances were listed as contributing to death
- The majority of drug-related deaths (41 cases, 55.4%) were polydrug overdoses; the remaining 33 cases (44.6%) were single-drug overdoses
- There was not substantial variation in the percentage of deaths involving specific substances by year; in all years, the most common substance was methamphetamine, followed by fentanyl
- About a quarter (25.7%) of drug-related deaths involved both fentanyl and methamphetamine

Common Substances Contributing to Death



Contributing Substances

Single-Drug Deaths	Count	Percent
Methamphetamine	27	81.8
Fentanyl	4	12.1
Methadone	2	6.1
Total Number of Decedents	33	

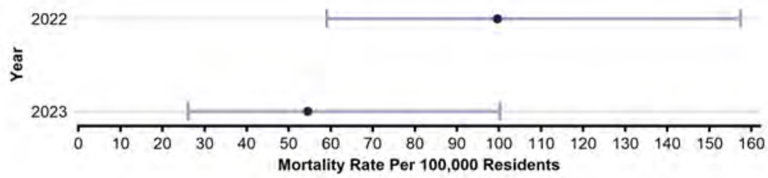
Polydrug Deaths	Count	Percent
Fentanyl	28	68.3
Methamphetamine	26	63.4
Buprenorphine	6	14.6
Diphenhydramine	5	12.2
Gabapentin	5	12.2
4-ANPP	4	9.8
Alprazolam	4	9.8
Cocaine	4	9.8
Hydrocodone	4	9.8
Oxycodone	4	9.8
Total Number of Decedents	41	

Johnson County

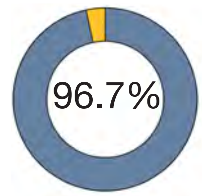
Drug-Related Deaths | 2022-2024

From 2022 to 2024, there were 30 drug-related deaths in Johnson County reported to WLJFC, accounting for 5.8% of all deaths. The total drug-related mortality rate in this time was 54.6 deaths per 100,000 residents, but this rate has been decreasing steadily since 2022. The mortality rate for 2024 cannot be calculated due to an extremely low number of deaths.

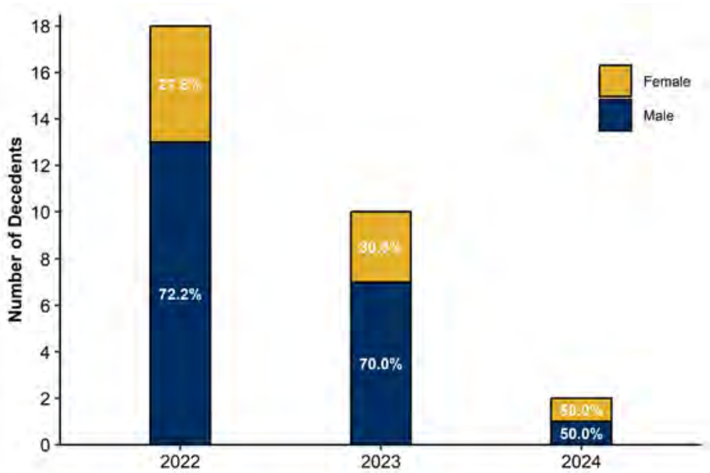
Drug-Related Mortality Rate by Year



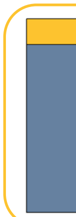
Most drug-related deaths were accidental in manner



Drug-Related Decedent Sex by Year



Overall, 70.0% of drug-related deaths in Johnson County from 2022 to 2024 were male, and 30.0% were female. These proportions are consistent across 2022 and 2023, but the count in 2024 is too low to analyze in this way.

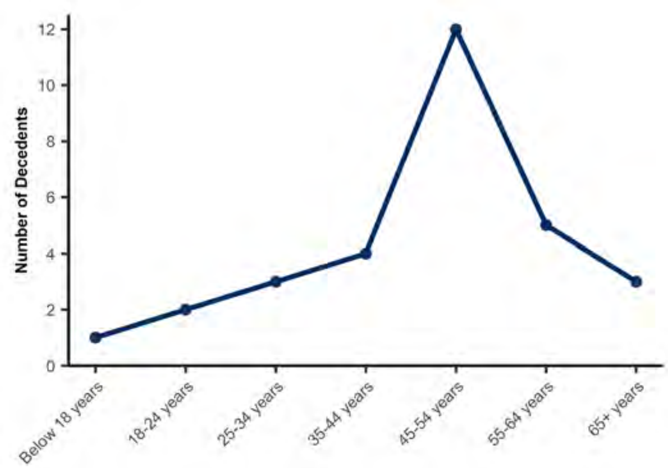


86.7% of decedents were white, non-Hispanic

The yearly counts are too small to present age groups separately, so we aggregate across years. We also present counts instead of rates due to small numbers in each age group.

The largest percentage (40.0%) of decedents are age 45 to 54. The average age at death overall was 47.4 years old. Male decedents had a slightly higher average age compared to female decedents: 48.4 years for males and 45.2 years for females. This difference is not statistically significant.

Drug-Related Decedent Age

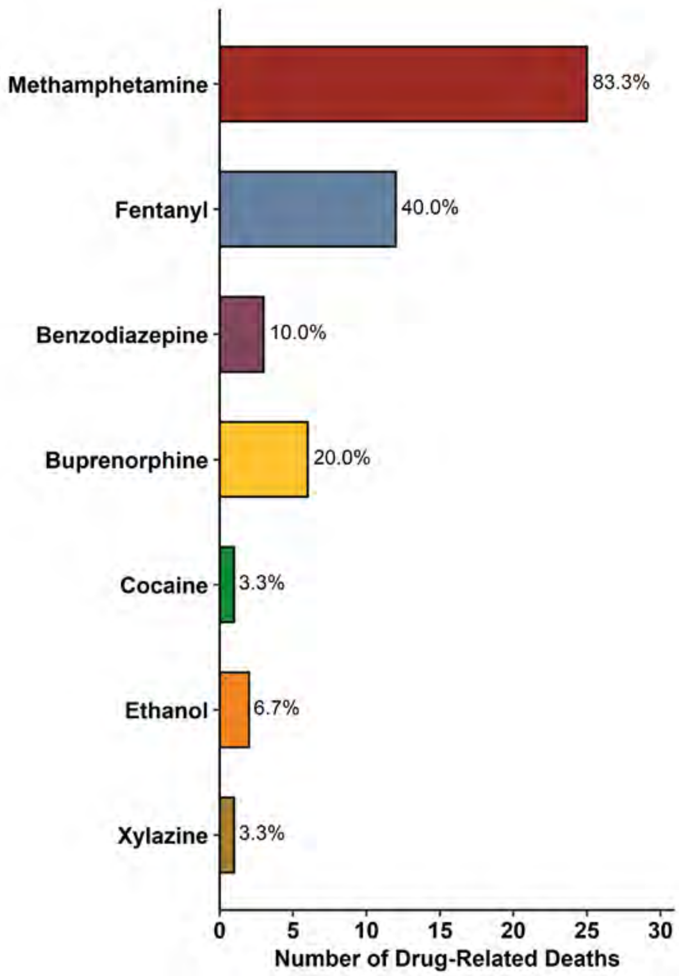


Drug-Related Deaths | 2022-2024

Drug-Related Death Characteristics

- An average of 5.10 substances were detected per decedent; an average of 1.96 substances were listed as contributing to death
- A small majority of drug-related deaths (16 cases, 53.3%) were polydrug overdoses; the remaining 14 cases (46.7%) were single-drug overdoses
- There was not substantial variation in the percentage of deaths involving specific substances by year; in all years, the most common substance was methamphetamine, followed by fentanyl
- About a third (33.3%) of drug-related deaths involved both fentanyl and methamphetamine

Common Substances Contributing to Death



Contributing Substances

Single-Drug Deaths	Count	Percent
Methamphetamine	10	71.4
Acetaminophen	1	7.1
Bromazolam	1	7.1
Fentanyl	1	7.1
Morphine	1	7.1
Total Number of Decedents	14	

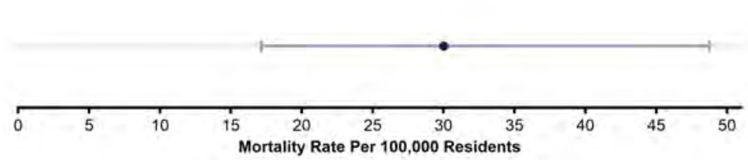
Polydrug Deaths	Count	Percent
Methamphetamine	15	93.8
Fentanyl	11	68.8
Buprenorphine	5	31.3
Ethanol	2	12.5
Acetaminophen	1	6.3
Amlodipine	1	6.3
Amphetamine	1	6.3
Bromazolam	1	6.3
Cocaine	1	6.3
Diazepam	1	6.3
Loperamide	1	6.3
Norbuprenorphine	1	6.3
Xylazine	1	6.3
para-Fluorofentanyl	1	6.3
Total Number of Decedents	16	

Unicoi County

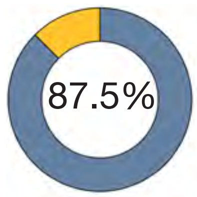
Drug-Related Deaths | 2022-2024

From 2022 to 2024, there were 16 drug-related deaths in Unicoi County reported to WLJFC, accounting for 2.3% of all deaths. The total drug-related mortality rate in this time was 30.0 deaths per 100,000 residents, and the figure below shows the confidence interval associated with that rate. The total count is too small to present yearly rates.

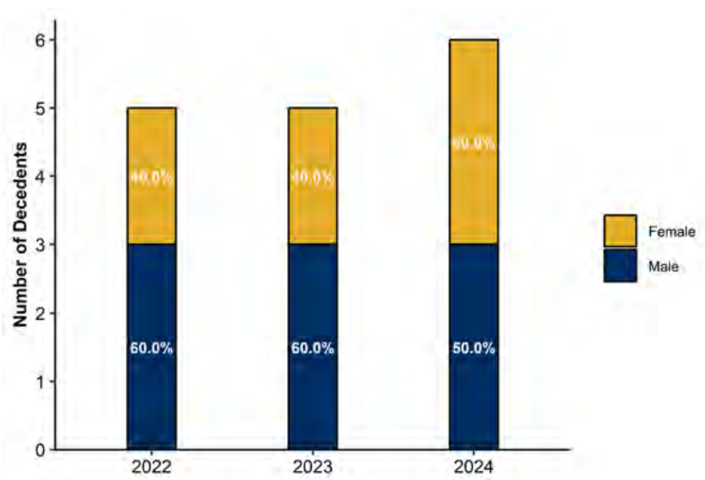
Drug-Related Mortality Rate



Most drug-related deaths were accidental in manner



Drug-Related Decedent Sex by Year



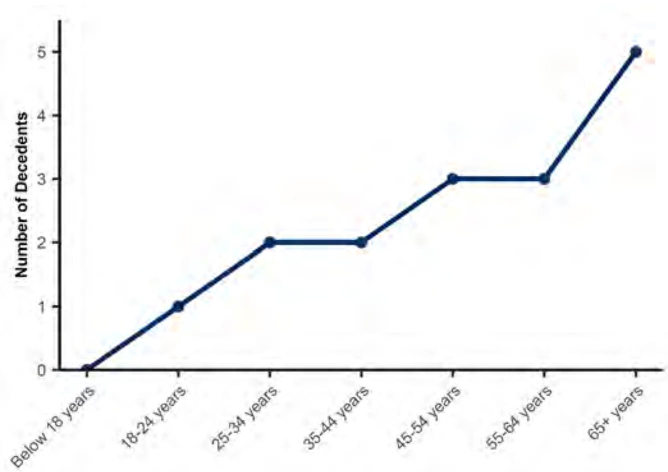
Overall, 56.2% of drug-related deaths in Unicoi County from 2022 to 2024 were male, and 43.8% were female. As the accompanying figure shows, the counts per year are too small to show any meaningful variation in this trend over time.

All decedents were white, non-Hispanic

The yearly counts are too small to present age groups separately, so we aggregate across years. We also present counts instead of rates due to small numbers in each age group.

The largest percentage (31.2%) of decedents are over the age of 65. The average age at death overall was 53.2 years old. Male and female decedents had similar average ages: 53.1 years for males and 53.3 years for females. We again caution that these overall counts are too small for interpretation.

Drug-Related Decedent Age

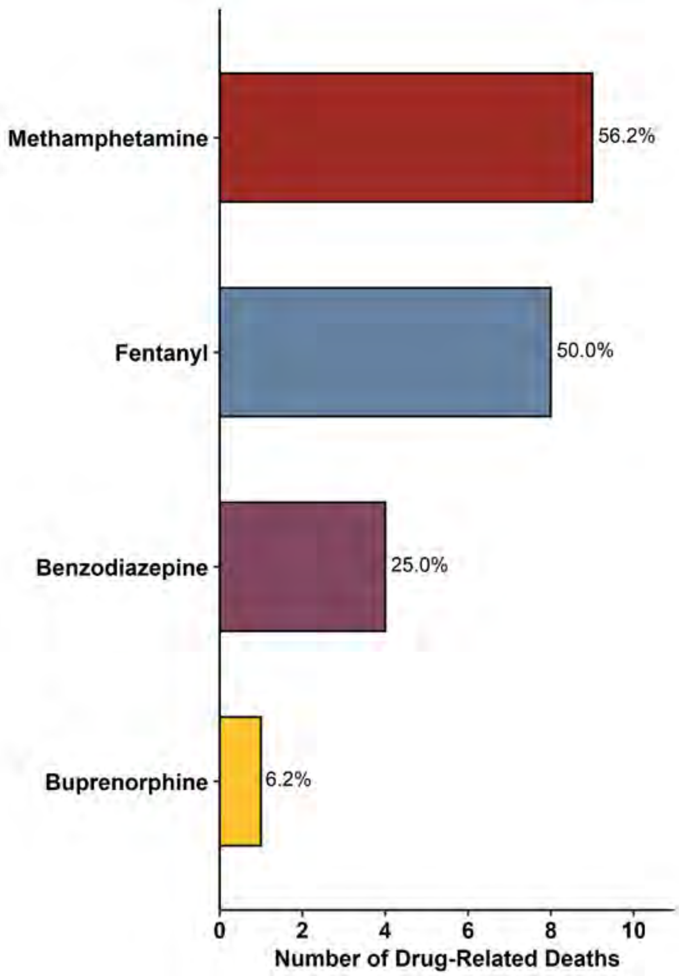


Drug-Related Deaths | 2022-2024

Drug-Related Death Characteristics

- An average of 6.44 substances were detected per decedent; an average of 2.25 substances were listed as contributing to death
- The majority of drug-related deaths (11 cases, 68.8%) were polydrug overdoses; the remaining 5 cases (31.2%) were single-drug overdoses
- There was not substantial variation in the percentage of deaths involving specific substances by year; in all years, the most common substance was methamphetamine, followed by fentanyl
- More than a third (37.5%) of drug-related deaths involved both fentanyl and methamphetamine

Common Substances Contributing to Death



Contributing Substances

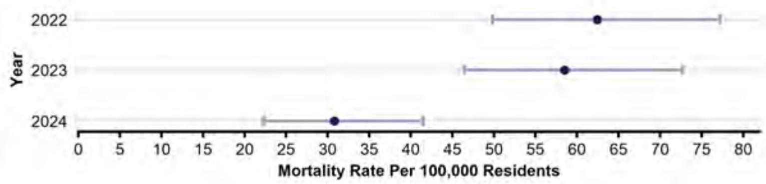
Single-Drug Deaths	Count	Percent
Methamphetamine	3	60.0
Fentanyl	1	20.0
Oxycodone	1	20.0
Total Number of Decedents	5	

Polydrug Deaths	Count	Percent
Fentanyl	7	63.6
Methamphetamine	6	54.5
Alprazolam	3	27.3
Hydroxyzine	2	18.2
7-Amino Clonazepam	1	9.1
Acetaminophen	1	9.1
Bromazolam	1	9.1
Buprenorphine	1	9.1
Bupropion	1	9.1
Cyclobenzaprine	1	9.1
Duloxetine	1	9.1
Ephedrine	1	9.1
Fluoxetine	1	9.1
Hydrocodone	1	9.1
Methadone	1	9.1
Oxycodone	1	9.1
Tramadol	1	9.1
Total Number of Decedents	11	

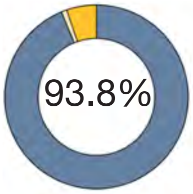
Drug-Related Deaths | 2022-2024

From 2022 to 2024, there were 209 drug-related deaths in Washington County reported to WLJFC, accounting for 2.7% of all deaths. The total drug-related mortality rate in this time was 50.5 deaths per 100,000 residents, but there was a decrease in the rate in 2024, dropping to 30.8 deaths per 100,000 residents. This decrease was statistically significant.

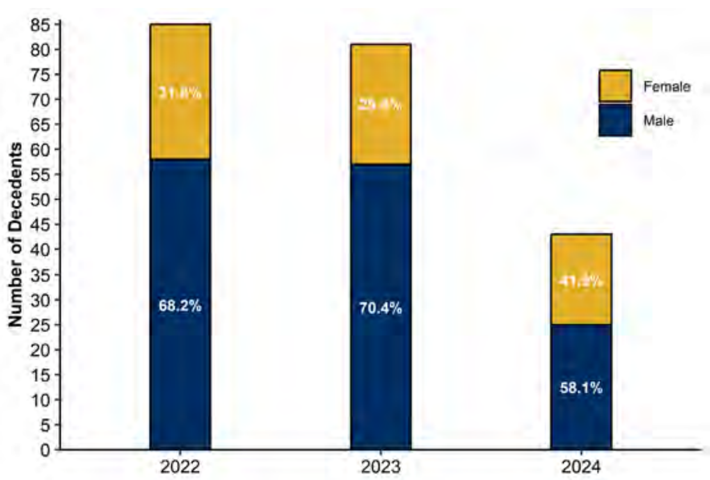
Drug-Related Mortality Rate by Year



Most drug-related deaths were accidental in manner



Drug-Related Decedent Sex by Year



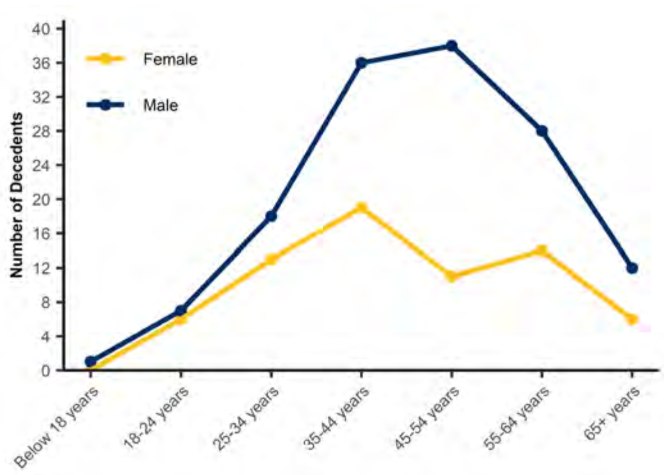
Overall, 67.0% of drug-related deaths in Washington County were male, and 33.0% were female. We see some variation in these proportions by year, as shown in the accompanying figure. In all years, the majority of decedents were male, but in 2024 that majority was a lower percentage than in previous years.

88.5% of decedents were white, non-Hispanic

The yearly counts are too small to present age groups separately, so we aggregate across years. We also present counts instead of rates due to small numbers in each age group.

The largest percentage (26.3%) of decedents are age 35 to 44. The average age at death overall was 46.0 years old. Male decedents had a relatively comparable average age as female decedents: 46.7 years for males and 44.8 years for females. This difference is not statistically significant.

Drug-Related Decedent Age by Sex

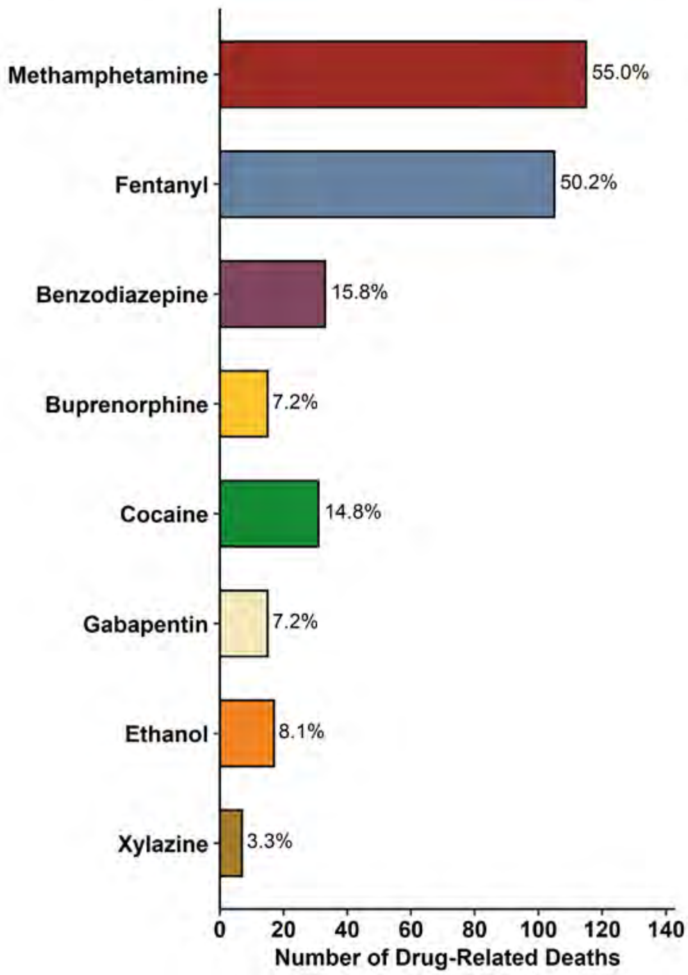


Drug-Related Deaths | 2022-2024

Drug-Related Death Characteristics

- An average of 5.94 substances were detected per decedent; an average of 2.31 substances were listed as contributing to death
- The majority of drug-related deaths (134 cases, 64.1%) were polydrug overdoses; the remaining 75 cases (35.9%) were single-drug overdoses
- There was some variation in the percentage of deaths involving specific substances by year; in 2022, the most common substance was fentanyl, but in subsequent years, the most common substance was methamphetamine
- About a quarter (25.4%) of drug-related deaths involved both fentanyl and methamphetamine

Common Substances Contributing to Death



Contributing Substances

Single-Drug Deaths	Count	Percent
Methamphetamine	46	61.3
Cocaine	9	12.0
Fentanyl	7	9.3
Total Number of Decedents	75	

Polydrug Deaths	Count	Percent
Fentanyl	97	72.4
Methamphetamine	69	51.5
Cocaine	20	14.9
Ethanol	16	11.9
Alprazolam	15	11.2
Gabapentin	14	10.4
Oxycodone	14	10.4
4-ANPP	13	9.7
Buprenorphine	13	9.7
para-Fluorofentanyl	10	7.5
Hydrocodone	9	6.7
Clonazepam	7	5.2
Diphenhydramine	7	5.2
Xylazine	7	5.2
Diazepam	5	3.7
Hydroxyzine	5	3.7
Promethazine	5	3.7
Total Number of Decedents	134	

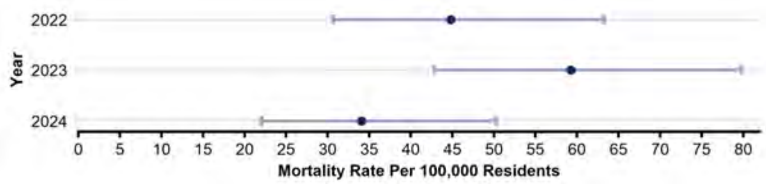
**Lists have been truncated for readability

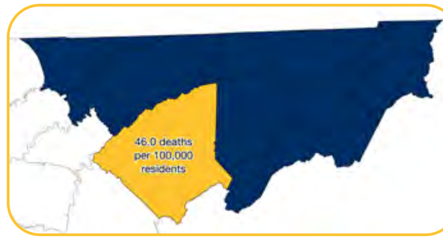
Greene County

Drug-Related Deaths | 2022-2024

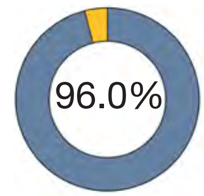
From 2022 to 2024, there were 100 drug-related deaths in Greene County reported to WLJFC, accounting for 3.7% of all deaths. The total drug-related mortality rate in this time was 46.0 deaths per 100,000 residents, but there has been a fair amount of fluctuation in the yearly rate, as shown below. None of these changes have been statistically significant.

Drug-Related Mortality Rate by Year

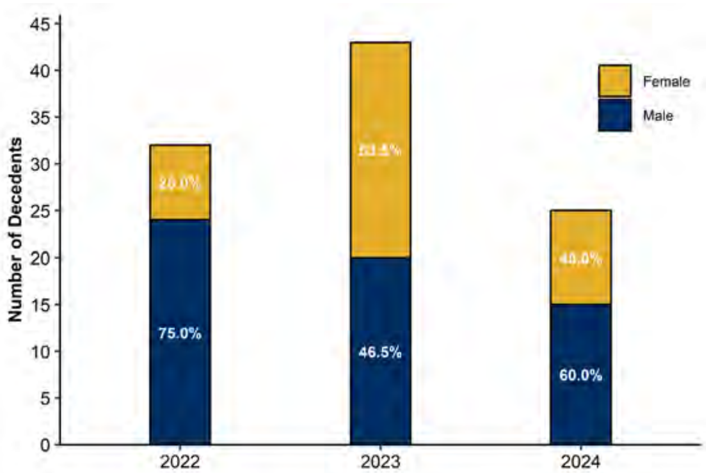




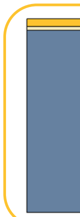
Most drug-related deaths were accidental in manner



Drug-Related Decedent Sex by Year



Overall, 59.0% of drug-related deaths in Greene County from 2022 to 2024 were male, and 41.0% were female. There is substantial variation in the proportions by year; in 2023, the majority of decedents were female, but in 2022 and 2024, the majority were male.

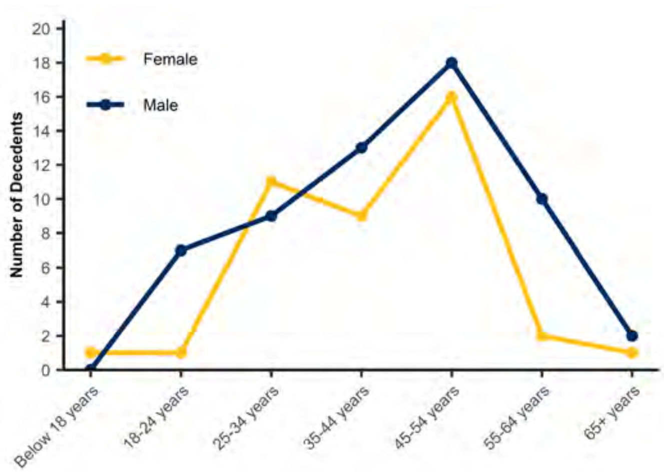


94.0% of decedents were white, non-Hispanic

The yearly counts are too small to present age groups separately, so we aggregate across years. We also present counts instead of rates due to small numbers in each age group.

The largest percentage (34.0%) of decedents are age 45 to 54. The average age at death overall was 42.7 years old. Male decedents had a relatively comparable average age as female decedents: 43.2 years for males and 41.8 years for females. This difference is not statistically significant.

Drug-Related Decedent Age by Sex

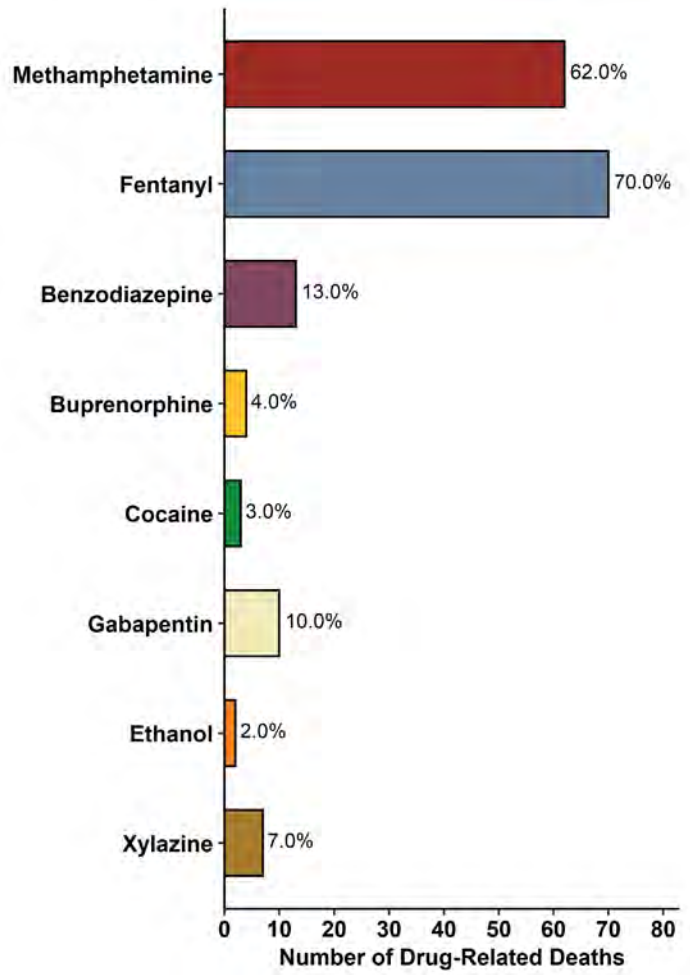


Drug-Related Deaths | 2022-2024

Drug-Related Death Characteristics

- An average of 6.17 substances were detected per decedent; an average of 2.38 substances were listed as contributing to death
- The majority of drug-related deaths (70 cases, 70.0%) were polydrug overdoses; the remaining 30 cases (30.0%) were single-drug overdoses
- There was some variation in the percentage of deaths involving specific substances by year; in 2022, the most common substance was methamphetamine, but in subsequent years, fentanyl was the most common
- 41.0% of drug-related deaths involved both fentanyl and methamphetamine

Common Substances Contributing to Death



Contributing Substances

Single-Drug Deaths	Count	Percent
Methamphetamine	16	53.3
Fentanyl	8	26.7
Cocaine	1	3.3
Diphenhydramine	1	3.3
Memantine	1	3.3
Methanol	1	3.3
Mirtazapine	1	3.3
Mitragynine	1	3.3
Total Number of Decedents	30	

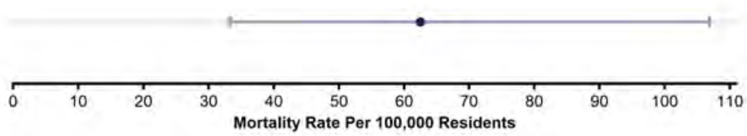
Polydrug Deaths	Count	Percent
Fentanyl	62	88.6
Methamphetamine	46	65.7
Gabapentin	10	14.3
Alprazolam	8	11.4
4-ANPP	7	10.0
Xylazine	7	10.0
Diphenhydramine	5	7.1
Hydrocodone	5	7.1
Oxycodone	5	7.1
para-Fluorofentanyl	5	7.1
Buprenorphine	4	5.7
Clonazepam	4	5.7
Oxymorphone	4	5.7
Total Number of Decedents	70	

HANCOCK COUNTY

Drug-Related Deaths | 2022-2024

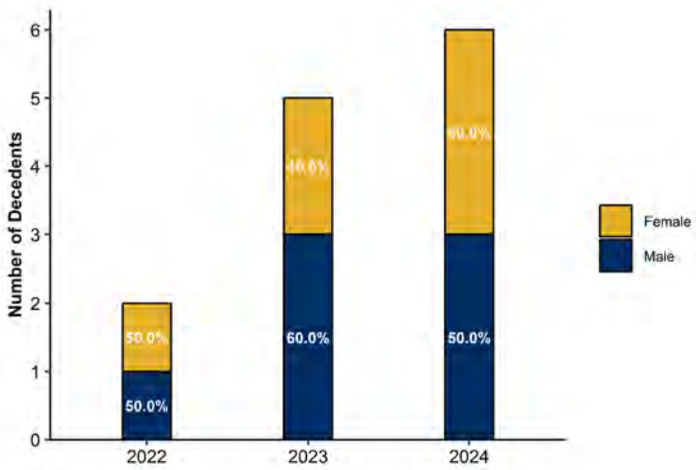
From 2022 to 2024, there were 13 drug-related deaths in Hancock County reported to WLJFC, accounting for 5.3% of all deaths. The total drug-related mortality rate in this time was 62.5 deaths per 100,000 residents, and the figure below shows the confidence interval associated with that rate. The total count is too small to present yearly rates.

Drug-Related Mortality Rate by Year



All drug-related deaths were accidental in manner

Drug-Related Decedent Sex by Year



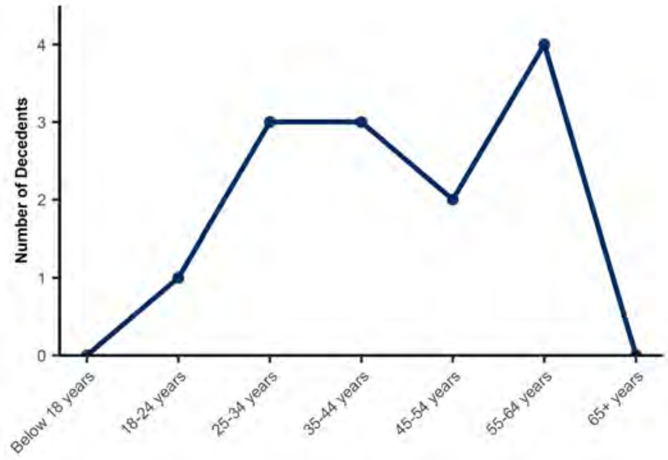
Overall, 53.8% of drug-related deaths in Hancock County from 2022 to 2024 were male, and 46.2% were female. As the accompanying figure shows, the counts per year are too small to show any meaningful variation in this trend over time.

All decedents were white, non-Hispanic

The yearly counts are too small to present age groups separately, so we aggregate across years. We also present counts instead of rates due to small numbers in each age group.

The largest percentage (30.8%) of decedents are age 55 to 64. The average age at death overall was 43.3 years old. Male decedents had a lower average age compared to female decedents: 39.7 years for males and 47.5 years for females. We again caution that these overall counts are too small for interpretation.

Drug-Related Decedent Age



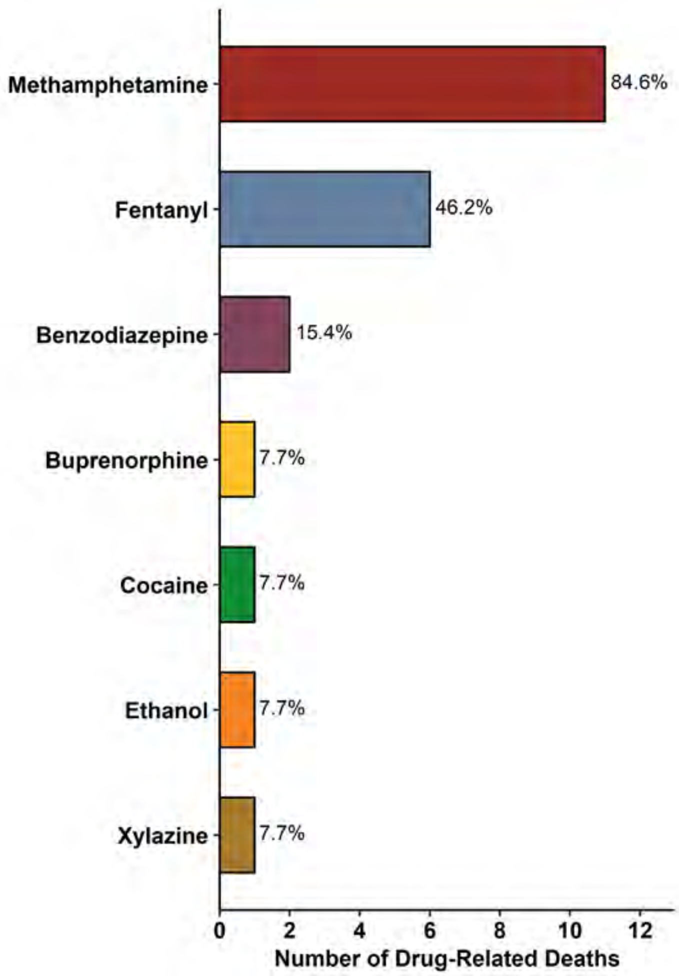
Hancock County

Drug-Related Deaths | 2022-2024

Drug-Related Death Characteristics

- An average of 7.08 substances were detected per decedent; an average of 2.62 substances were listed as contributing to death
- A slight majority of drug-related deaths (7 cases, 53.8%) were polydrug overdoses; the remaining 6 cases (46.2%) were single-drug overdoses
- There was not substantial variation in the percentage of deaths involving specific substances by year; in all years, the most common substance was methamphetamine, followed by fentanyl
- 38.5% of drug-related deaths involved both fentanyl and methamphetamine

Common Substances Contributing to Death



Contributing Substances

Single-Drug Deaths	Count	Percent
Methamphetamine	6	100
Total Number of Decedents	6	

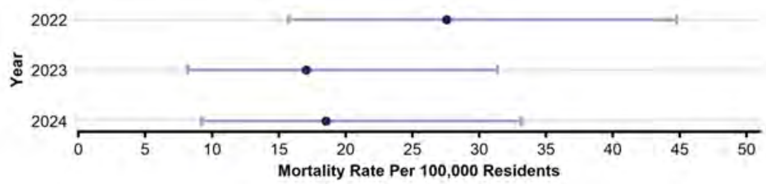
Polydrug Deaths	Count	Percent
Fentanyl	6	85.7
Methamphetamine	5	71.4
4-ANPP	3	42.9
Alprazolam	2	28.6
para-Fluorofentanyl	2	28.6
6-Monoacetylmorphine	1	14.3
Acetyl Fentanyl	1	14.3
Buprenorphine	1	14.3
Butalbital	1	14.3
Cocaine	1	14.3
Ethanol	1	14.3
Methadone	1	14.3
Oxycodone	1	14.3
Phenobarbital	1	14.3
Xylazine	1	14.3
Total Number of Decedents	7	

Hawkins County

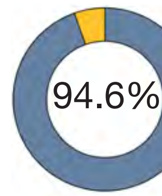
Drug-Related Deaths | 2022-2024

From 2022 to 2024, there were 37 drug-related deaths in Hawkins County reported to WLJFC, accounting for 2.1% of all deaths. The total drug-related mortality rate in this time was 21.0 deaths per 100,000 residents, but there has been some degree of fluctuation in the yearly rate, as shown below. None of these changes have been statistically significant.

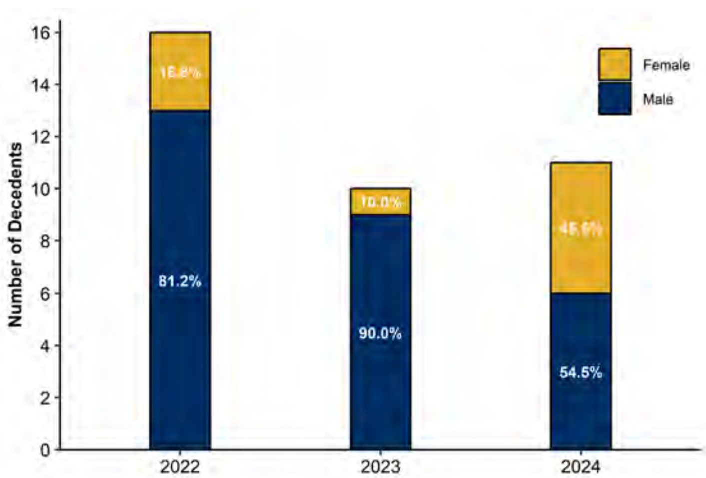
Drug-Related Mortality Rate by Year



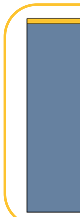
Most drug-related deaths were accidental in manner



Drug-Related Decedent Sex by Year



Overall, 75.7% of drug-related deaths in Hawkins County from 2022 to 2024 were male, and 24.3% were female. There is substantial variation in these proportions by year, but we caution that the yearly totals are too small for statistical interpretation.

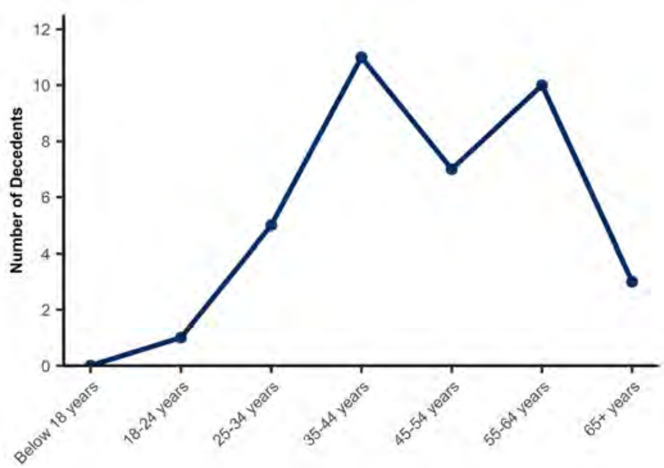


97.3% of decedents were white, non-Hispanic

The yearly counts are too small to present age groups separately, so we aggregate across years. We also present counts instead of rates due to small numbers in each age group.

The largest percentage (29.7%) of decedents are age 35 to 44. The average age at death overall was 47.9 years old. Male decedents had a higher average age compared to female decedents: 49.2 years for males and 43.7 years for females. Small counts mean that this difference is not statistically significant.

Drug-Related Decedent Age

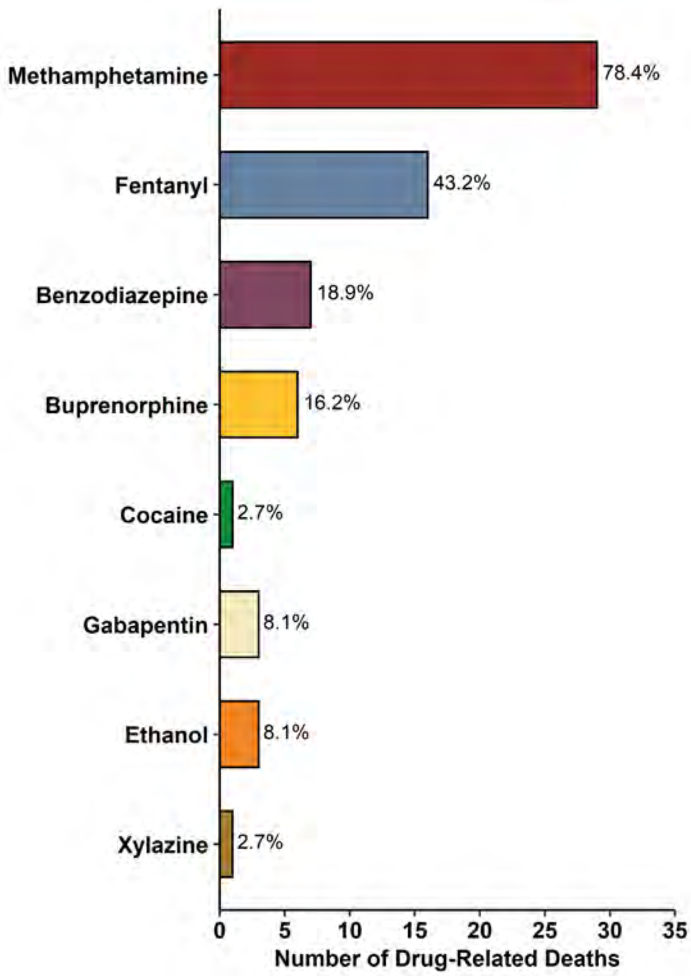


Drug-Related Deaths | 2022-2024

Drug-Related Death Characteristics

- An average of 5.46 substances were detected per decedent; an average of 2.27 substances were listed as contributing to death
- The majority of drug-related deaths (26 cases, 70.3%) were polydrug overdoses; the remaining 11 cases (29.7%) were single-drug overdoses
- There was not substantial variation in the percentage of deaths involving specific substances by year; in all years, the most common substance was methamphetamine, followed by fentanyl
- Approximately a third (35.1%) of drug-related deaths involved both fentanyl and methamphetamine

Common Substances Contributing to Death



Contributing Substances

Single-Drug Deaths	Count	Percent
Methamphetamine	9	81.8
Fentanyl	1	9.1
Oxymorphone	1	9.1
Total Number of Decedents	11	

Polydrug Deaths	Count	Percent
Methamphetamine	20	76.9
Fentanyl	15	57.7
Buprenorphine	6	23.1
Alprazolam	3	11.5
Ethanol	3	11.5
Gabapentin	3	11.5
Clonazepam	2	7.7
Diphenhydramine	2	7.7
Doxepin	2	7.7
Oxycodone	2	7.7
Total Number of Decedents	26	

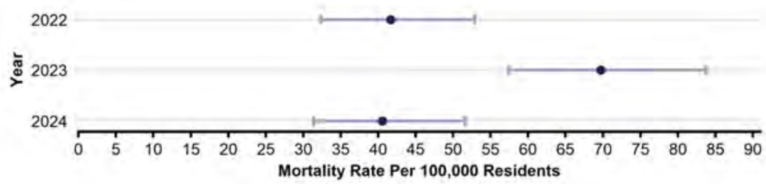
**Polydrug list has been truncated for readability

SULLIVAN COUNTY

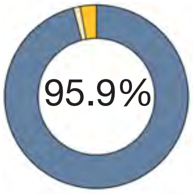
Drug-Related Deaths | 2022-2024

From 2022 to 2024, there were 246 drug-related deaths in Sullivan County reported to WLJFC, accounting for 2.4% of all deaths. The total drug-related mortality rate in this time was 50.7 deaths per 100,000 residents, rate in 2023 was much higher than 2022 or 2024, as shown below. This difference was statistically significant.

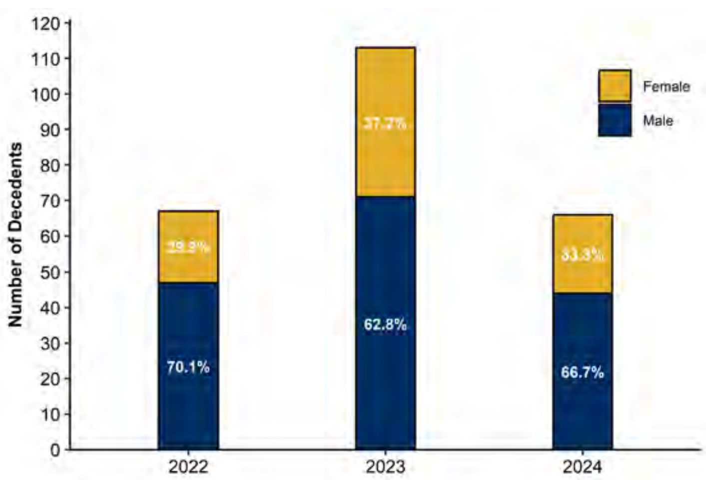
Drug-Related Mortality Rate by Year



Most drug-related deaths were accidental in manner



Drug-Related Decedent Sex by Year



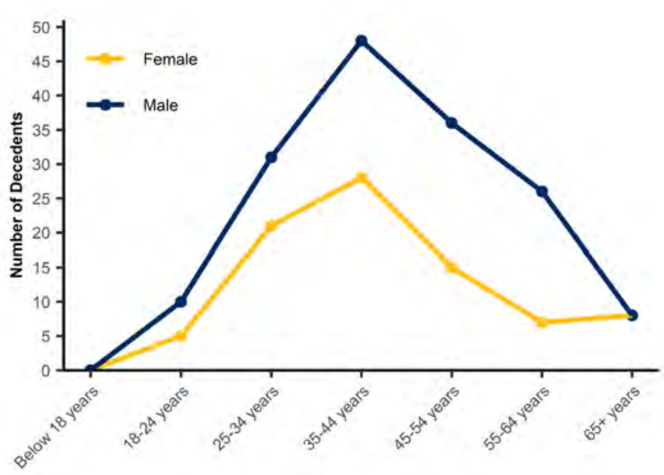
Overall, 65.9% of drug-related deaths in Sullivan County from 2022 to 2024 were male, and 34.1% were female. We see some small variation in these proportions by year, as shown in the accompanying figure, but in all years, the majority of decedents were male.

94.3% of decedents were white, non-Hispanic

The yearly counts are too small to present age groups separately, so we aggregate across years. We also present counts instead of rates due to small numbers in each age group.

The largest percentage (30.9%) of decedents are age 35 to 44. The average age at death overall was 43.1 years old. Male decedents a comparable average age as female decedents: 43.6 years for males and 42.2 years for females. This difference is not statistically significant.

Drug-Related Decedent Age by Sex

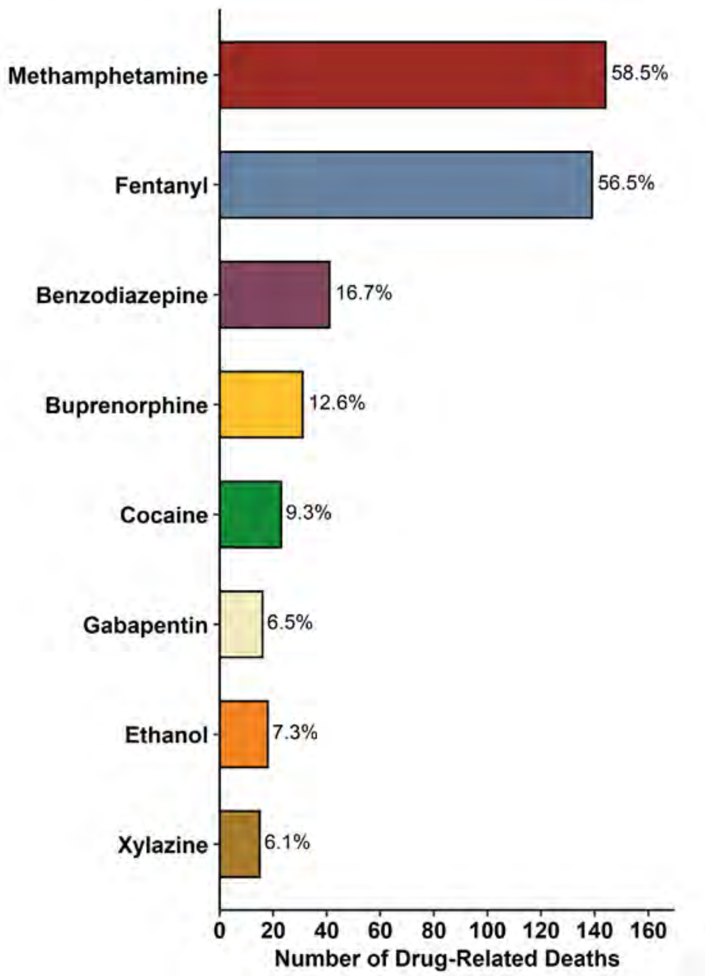


Drug-Related Deaths | 2022-2024

Drug-Related Death Characteristics

- An average of 6.22 substances were detected per decedent; an average of 2.31 substances were listed as contributing to death
- The majority of drug-related deaths (149 cases, 60.6%) were polydrug overdoses; the remaining 97 cases (39.4%) were single-drug overdoses
- There was some variation in the percentage of deaths involving specific substances by year; in 2022 and 2023, the most common substance was fentanyl, but in 2024, the most common was methamphetamine
- Almost a third (29.3%) of drug-related deaths involved both fentanyl and methamphetamine

Common Substances Contributing to Death



Contributing Substances

Single-Drug Deaths	Count	Percent
Methamphetamine	50	51.5
Fentanyl	31	32.0
Cocaine	4	4.1
Oxycodone	3	3.1
Ethanol	2	2.1
Total Number of Decedents	97	

Polydrug Deaths	Count	Percent
Fentanyl	108	72.5
Methamphetamine	94	63.1
Buprenorphine	31	20.8
Alprazolam	18	12.1
Cocaine	17	11.4
Ethanol	16	10.7
Gabapentin	16	10.7
Xylazine	15	10.1
4-ANPP	14	9.4
Promethazine	11	7.4
Oxycodone	10	6.7
Diphenhydramine	8	5.4
para-Fluorofentanyl	8	5.4
Diazepam	6	4.0
Hydroxyzine	6	4.0
Morphine	6	4.0
Total Number of Decedents	149	

**Polydrug list has been truncated for readability

IV. Substance-Specific Trends

In this section, we will consider the characteristics of drug-related deaths that involve the same substance. The goal here is to attempt to isolate trends specific to individual substances that may help inform prevention and treatment efforts. While the discussion of statistical analysis below is limited for readability, full descriptions of the statistical models run are available upon request.

We are examining the most common substances indicated in drug-related deaths reported to WLJFC: methamphetamine, fentanyl, and all benzodiazepines. We also present information on deaths involving buprenorphine because it is a substance of particular interest in the addiction research community.

Methamphetamine-Involved Deaths

From 2022 to 2024, there were 448 decedents reported to WLJFC with methamphetamine listed as a substance contributing to death. The majority of drug-related deaths (61.8%) involved methamphetamine, and the associated mortality rate of methamphetamine-involved deaths in this time period is 28.1 deaths per 100,000 residents.

The majority of these deaths (246 cases, 54.9%) occurred in non-jurisdictional counties, and the remaining 202 (45.1%) occurred in jurisdictional counties. Table 4.1 shows county-level statistics for methamphetamine-involved deaths, including percentages and rates.

Table 4.1 Methamphetamine-Involved Mortality Rates by County, 2022-2024 (N = 448)

	Methamphetamine Death Count	Percentage of Drug Deaths	Mortality Rate Per 100,000 Residents	95% CI
Jurisdictional Counties				
Carter	53	71.6	31.0	23.2 - 40.6
Johnson	25	83.3	45.5	29.4 - 67.2
Unicoi	9	56.3	*	*
Washington	115	55.0	27.8	22.9 - 33.3
Non-Jurisdictional Counties				
Greene	62	62.0	28.5	21.9 - 36.6
Hancock	11	84.6	52.9	26.4 - 94.6
Hawkins	29	78.4	16.5	11.0 - 23.7
Sullivan	144	58.5	29.7	25.0 - 34.9
Total	448	61.8	28.1	25.6 - 30.8

In all counties, methamphetamine was a contributing substance for more than half of all drug-related deaths. The largest percentage of methamphetamine-involved deaths was technically Hancock County, but the total number of drug-related deaths in this county is low overall, so we remind the reader that statistics based on small numbers tend to be very unstable. The next highest percentage occurred in Johnson County, where 83.3% of drug deaths involved methamphetamine.

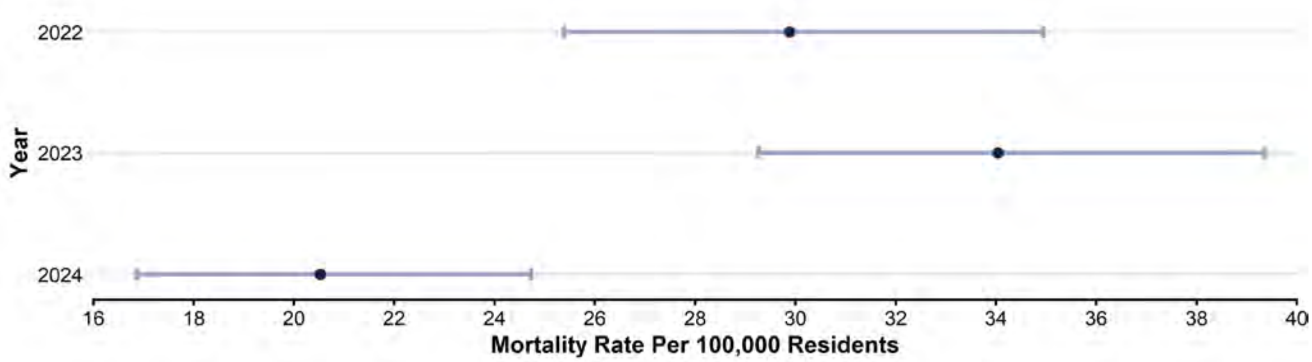
The highest methamphetamine mortality rate was again technically in Hancock County, so the same small-count caveat applies to this statistic. The next highest rate was in Johnson County, at 45.5 methamphetamine-involved deaths per 100,000 residents. No rate was tabulated for Unicoi County due to counts below 10.

Map 4.1 Methamphetamine-Involved Percentage by County, 2022-2024 (N = 448)

Map 4.1 above shows the percentages of drug deaths that involved methamphetamine for each county from 2022 to 2024 for visual comparison with Table 4.1. We have displayed percentages instead of mortality rates because not all counties have calculable rates.

As in previous sections, it is also useful to look at the fluctuation in methamphetamine-involved deaths by year. From 2022 to 2023, there was a slight increase in the total number, but in 2024, there was a substantial decrease (39.2% drop from 2023 to 2024). It is useful to examine these changes using mortality rates with confidence intervals, as shown in Fig 4.1 below.

Fig 4.1 Methamphetamine-Involved Mortality Rate by Year, 2022-2024 (N = 448)



We can see substantial overlap in the 95% confidence intervals associated with the rates in 2022 and 2023, meaning that even though the calculated rates are slightly different, we cannot conclude that the difference is statistically significant.

The methamphetamine-involved mortality rate in 2024 is significantly lower than either previous year, as indicated by the confidence intervals shown. This suggests that the substantial decrease in drug-related deaths overall documented in Section II may be driven to a certain extent by a corresponding decrease in methamphetamine mortality. Additional data years will help clarify this potential effect.

For the remainder of this section, we will be interested in comparing the statistics for methamphetamine-involved deaths to the statistics for drug deaths that do not involve methamphetamine.

To do this, we will use a technique called chi-square independence testing, in addition to comparing rates using confidence intervals when appropriate. Chi-square testing is a process that allows us to determine whether the difference between two groups is more likely to be due to random chance or that there is an actual relationship between the groups. In our specific case, what we will be testing is whether or not the proportion of methamphetamine-involved deaths is different from the proportion of non-methamphetamine drug deaths.

Fig 4.2 shows the percentage breakdown of methamphetamine-involved deaths by manner. While we have seen that overall, the majority of drug-related deaths are accidental in manner (95.4%), the percentage of accidental methamphetamine deaths is even higher (99.6%). This difference is statistically significant, verified using chi-square testing.

Figure 4.2 Methamphetamine-Involved Deaths by Manner, 2022-2024 (N = 448)

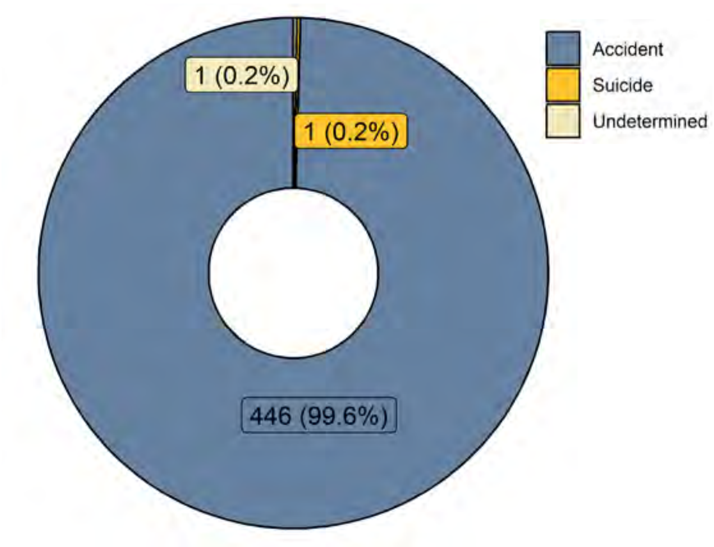


Table 4.2 Methamphetamine-Involved Mortality Rates by Demographic, 2022-2024 (N = 448)

	Count	Percent	Rate Per 100,000 Residents	95% CI
Sex				
Male†	297	66.3	**37.7**	**33.5 - 42.2**
Female†	151	33.7	**18.7**	**15.9 - 22.0**
Race				
White†	428	95.5	**28.6**	**26.0 - 31.5**
Black	20	4.5	45.6	27.9 - 70.4
Other*	0	0.0	*	*
Ethnicity				
Not Hispanic	447	99.8	*	*
Hispanic	1	0.2		*
Age at Death				
Below 18 years	1	0.2	*	*
18-24 years	15	3.3	10.5	5.9 - 17.3
25-34 years	70	15.6	35.9	27.9 - 45.3
35-44 years†	116	25.9	**64.3**	**53.1 - 77.1**
45-54 years†	132	29.5	**64.1**	**53.7 - 76.1**
55-64 years†	90	20.1	**39.5**	**31.8 - 48.6**
65+ years	24	5.4	6.9	4.4 - 10.3

* Aggregated category includes Asian and unspecified Other racial classifications

† Methamphetamine-involved mortality rate is significantly higher than non-methamphetamine mortality rate

Table 4.2 shows the percentage and mortality rate calculations for methamphetamine-involved deaths aggregated across all years. Mortality rates that are significantly different from non-methamphetamine rates are either shown in bold (higher) or italics (lower).

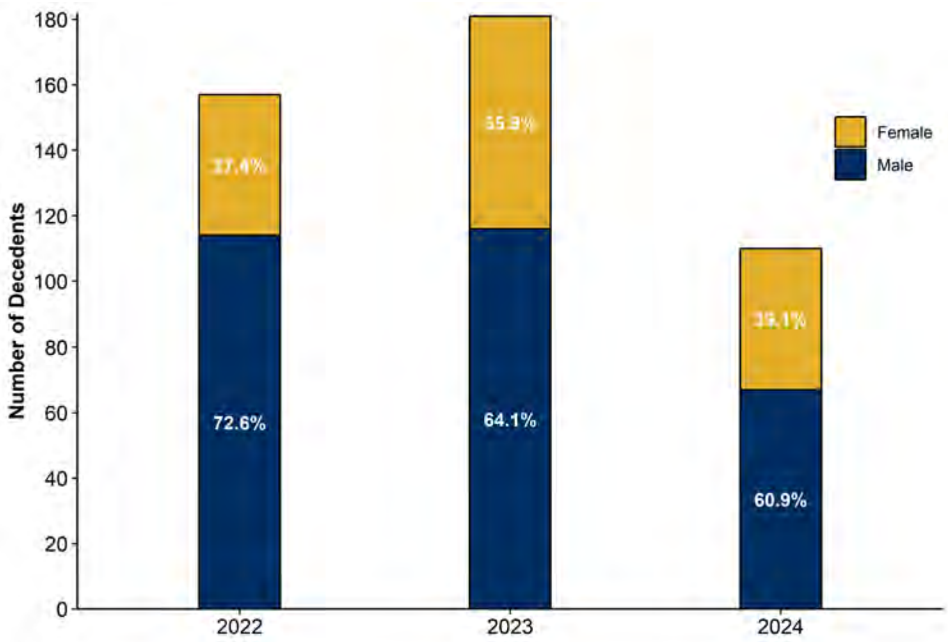
The majority of decedents are male compared to female; statistical testing reveals some nuance to this, however. When looking at the proportion of male decedents to female decedents, chi-square testing does *not* find a significant difference, meaning that the proportion of male to female is about the same for methamphetamine-involved deaths compared to non-methamphetamine deaths.

Despite this, when we compare the mortality rates between these groups, we actually see that the rate of methamphetamine deaths for both sexes is higher than for non-methamphetamine deaths, and this difference is statistically significant.

Interestingly, we also see some variation in the proportion of male to female methamphetamine-involved deaths by year. Fig 4.3 shows these proportions, and we can see that from 2022 to 2024, the percentage of male decedents decreases. The count in 2023 is roughly the same as the count in 2022, but we see that the count of 2023 female decedents increased, meaning that the overall proportion still dropped.

This complexity is compelling and suggests that there may be other factors at play, indicating that a more sophisticated analysis might reveal additional information. As we continue to collect future data years, this is an effect that warrants further attention.

Figure 4.3 Methamphetamine-Involved Decedent Sex by Year, 2022-2024 (N = 448)



The difference between methamphetamine and non-methamphetamine deaths is more straightforward when comparing across racial groups. While the majority of all drug-related deaths reported to WLJFC are among white decedents, methamphetamine deaths are even more likely to be white individuals: 95.5% of methamphetamine deaths compared to 89.5% of non-methamphetamine deaths. This difference is statistically significant using chi-square testing. Additionally, the methamphetamine mortality rate for white decedents is statistically higher than non-methamphetamine deaths; the rate for black decedents is slightly lower for methamphetamine deaths, but that difference is not statistically different.

When considering differences comparing by age, the analysis is more complex due to the fact that age is a continuous number, rather than a discrete factor like sex or race. There are several techniques we can utilize, but for the purposes of this report, we will limit ourselves to a more basic analysis.

On average, methamphetamine-involved deaths have a higher age at death compared with non-methamphetamine deaths. While this difference itself is not statistically significant – 46.0 years for methamphetamine deaths compared to 43.8 years otherwise – other testing indicates that the overall age distribution of methamphetamine deaths is significantly different from non-amphetamine deaths.

We can see this in Table 4.2 when we look at the mortality rate data more closely. The methamphetamine-involved mortality rate for decedents between 35 and 64 is significantly higher than non-methamphetamine rates. No age group had a lower rate than non-methamphetamine deaths. Fig 4.4 on the next page shows this distribution difference visually; we can see two distinctly different shapes.

Because we are also interested in differences by sex, Fig 4.5 shows the age distribution of methamphetamine-involved deaths by sex. Note that this is count data rather than rate data; several age categories by sex have fewer than 10 decedents, so we cannot calculate rates for all categories. On average, male decedents are older than female decedents: 47.7 years old for male decedents compared to 42.5 years old for female decedents. This difference is statistically significant.

Figure 4.4 Mortality Rates by Age at Death by Substance Type, 2022-2024 (N = 725)

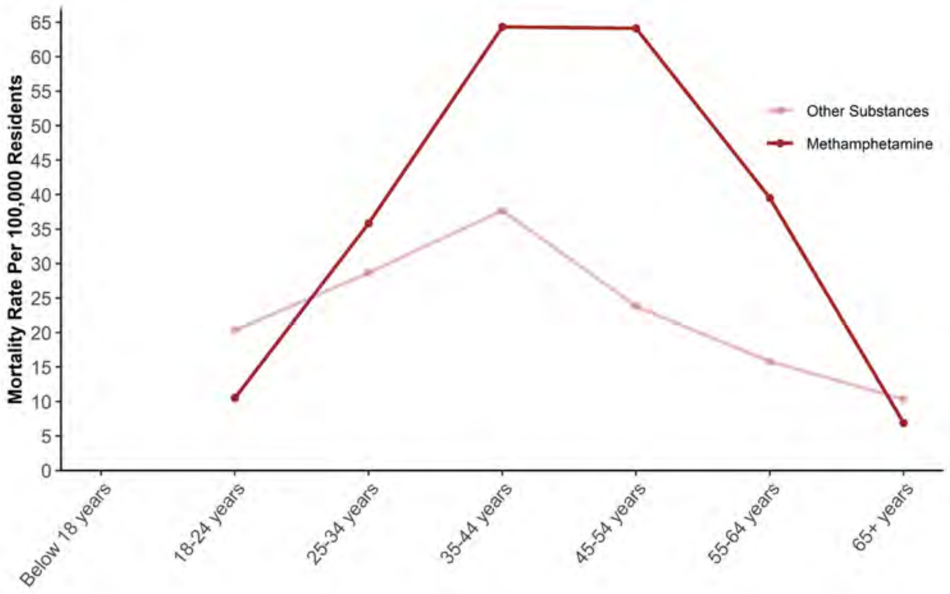
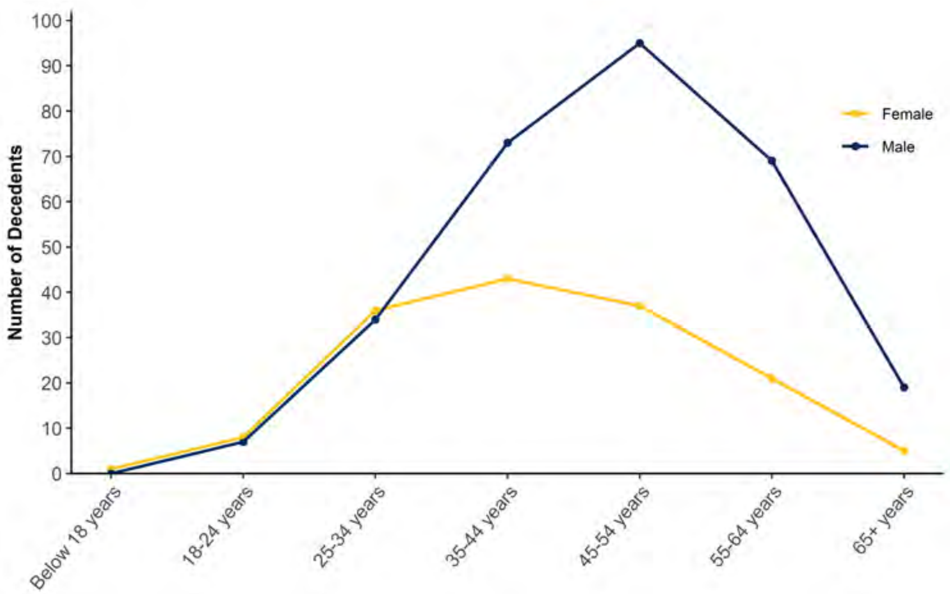
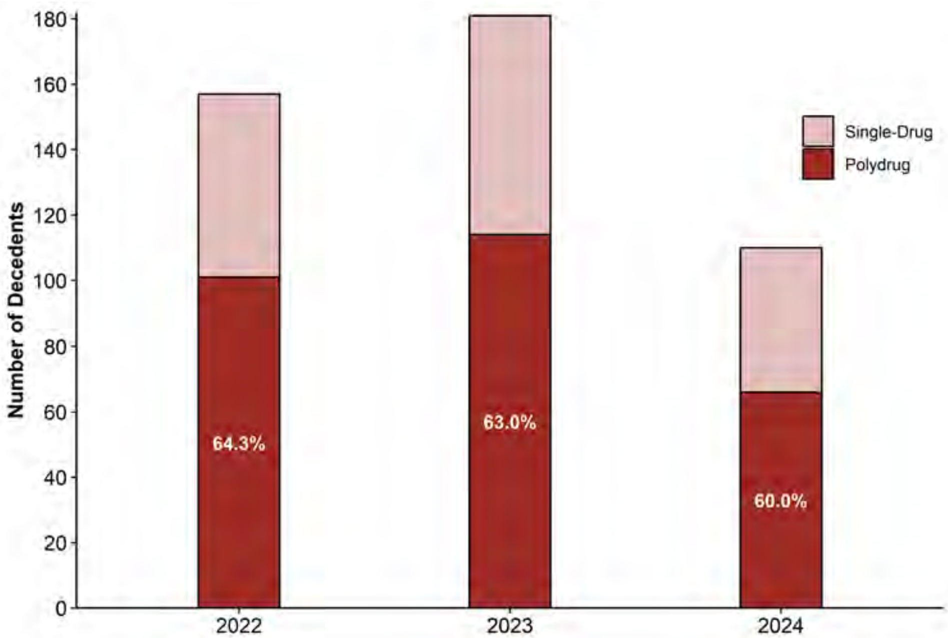


Figure 4.5 Methamphetamine-Involved Deaths by Age by Sex, 2022-2024 (N = 448)



Finally, we turn our attention to the other potential substances contributing to methamphetamine-involved deaths. Overall, 62.7% of methamphetamine-involved deaths are polydrug, meaning that one or more additional substances were listed by the certifier as contributing to death. This percentage is relatively stable in all data years, as shown in Fig 4.6. A similar percentage of non-methamphetamine deaths are polydrug (62.5%), and chi-square testing verified that this difference is not statistically significant.

Figure 4.6 Methamphetamine-Involved Polydrug Deaths by Year, 2022-2024 (N = 448)



We looked at the number of substances positive on the toxicology results for methamphetamine-involved deaths, as well as the total number of substances stated as contributing to death. Methamphetamine-involved deaths have an average of 2.19 substances contributing to death compared to 2.38 substances contributing to death in all other cases. This difference is not statistically significant. When we look at the overall distribution of number of contributing substances, there is some small suggestion that there's a difference for methamphetamine-involved deaths. This is another case where additional data years may clarify the trend.

Likely of more interest are the specific substances themselves. Table 4.3 below lists the most common substances present in polydrug methamphetamine-involved deaths for five or more decedents. Almost seventy-eight percent (77.6%) of polydrug methamphetamine deaths also involved fentanyl. No other substance was present to that high a degree; the next most common substance was buprenorphine, present in 15.3% of polydrug methamphetamine deaths.

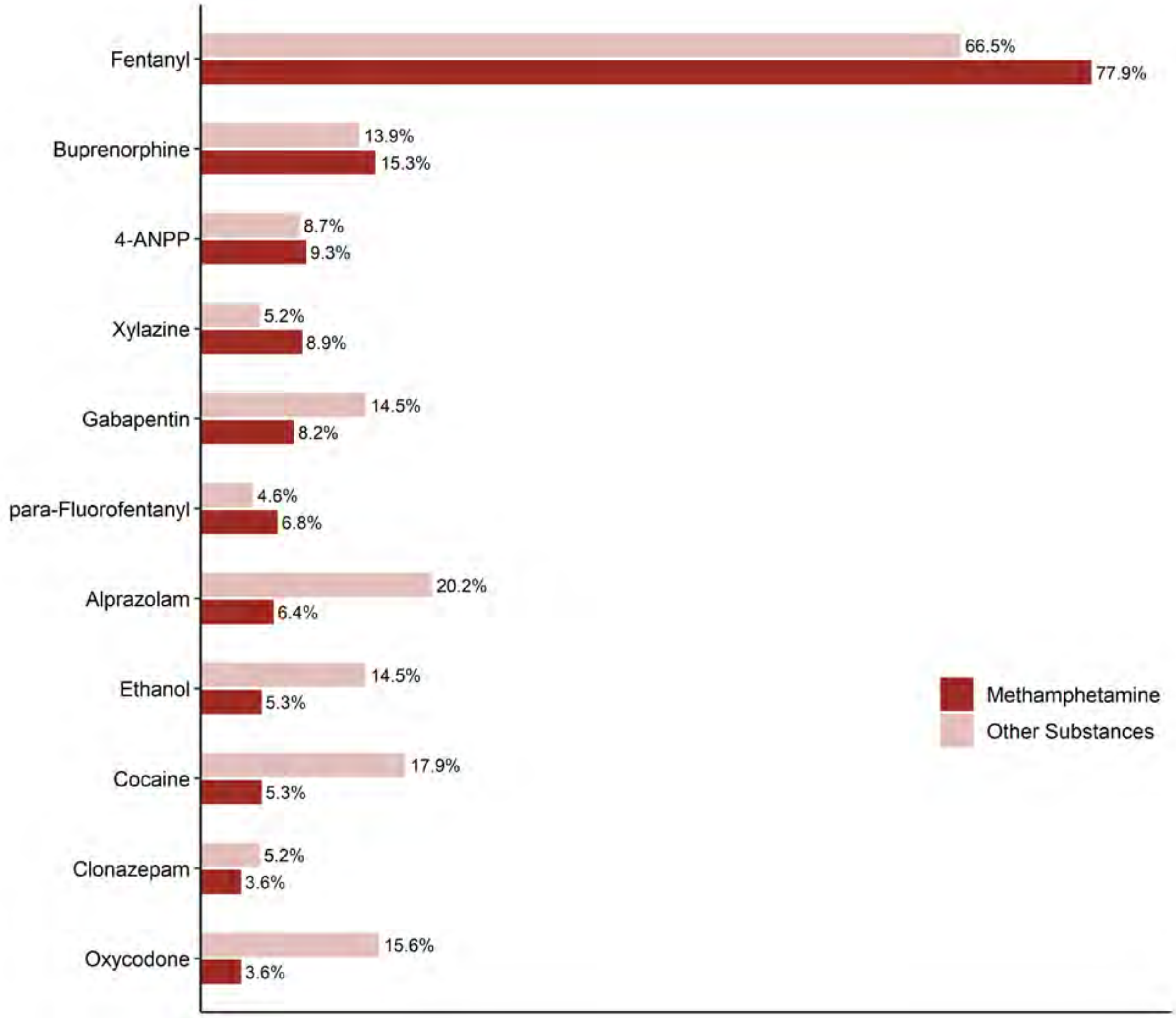
Table 4.3 Additional Substances in Polydrug Methamphetamine Deaths, 2022-2024 (N = 281)

	Count	Percent
Fentanyl	219	77.9
Buprenorphine	43	15.3
4-ANPP	26	9.3
Xylazine	25	8.9
Gabapentin	23	8.2
para-Fluorofentanyl	19	6.8
Alprazolam	18	6.4
Cocaine	15	5.3
Ethanol	15	5.3
Clonazepam	10	3.6
Oxycodone	10	3.6
6-Monoacetylmorphine	9	3.2
Acetyl Fentanyl	8	2.8
Diazepam	7	2.5
Diphenhydramine	7	2.5
Hydrocodone	7	2.5
Morphine	7	2.5
7-Amino Clonazepam	6	2.1
Hydroxyzine	5	1.8
Total Number of Decedents	281	

Fig 4.7 compares these percentages to the percentages of non-methamphetamine polydrug deaths involving the same substances. We see a substantial amount of variation in these values; fentanyl, para-fluorofentanyl (a fentanyl analog), and xylazine are substantially more common in methamphetamine polydrug deaths. Alprazolam, ethanol, cocaine, gabapentin, clonazepam, and oxycodone were all more common in non-methamphetamine polydrug deaths. Buprenorphine and 4-ANPP (a fentanyl precursor) both have a relatively comparable percentage of decedents across both groups.

We also note that there were several substances present in much higher percentages of non-methamphetamine polydrug deaths not shown because they were either not present at all in methamphetamine deaths or in such low counts that they were truncated. Some of these substances include diphenhydramine, hydrocodone, and promethazine.

Figure 4.7 Additional Substances in Polydrug Deaths, 2022-2024 (N = 454)



Fentanyl-Involved Deaths

From 2022 to 2024, there were 388 decedents reported to WLJFC with fentanyl listed as a substance contributing to death. About fifty-four percent of drug-related deaths (53.5%) involved fentanyl, and the associated mortality rate of fentanyl-involved deaths in this time period is 24.4 deaths per 100,000 residents.

The majority of these deaths (231 cases, 59.5%) occurred in non-jurisdictional counties, and the remaining 157 (40.5%) occurred in jurisdictional counties. Table 4.4 shows county-level statistics for fentanyl-involved deaths, including percentages and rates.

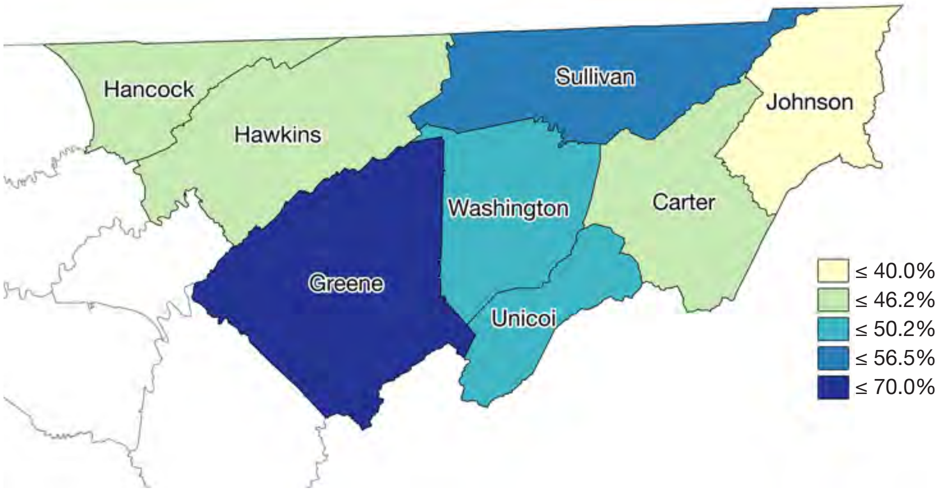
Table 4.4 Fentanyl-Involved Mortality Rates by County, 2022-2024 (N = 388)

	Fentanyl Death Count	Percentage of Drug Deaths	Mortality Rate Per 100,000 Residents	95% CI
Jurisdictional Counties				
Carter	32	43.2	18.7	12.8 - 26.4
Johnson	12	40.0	21.8	11.3 - 38.2
Unicoi	8	50.0	*	*
Washington	105	50.2	25.3	20.7 - 30.7
Non-Jurisdictional Counties				
Greene	70	70.0	32.2	25.1 - 40.7
Hancock	6	46.2	*	*
Hawkins	16	43.2	9.1	5.2 - 14.8
Sullivan	139	56.5	28.6	24.1 - 33.8
Total	388	53.5	24.4	22.0 - 26.9

In all counties, fentanyl was a contributing substance for a relatively large percentage of all drug-related deaths, although we observe that the number of fentanyl deaths in Hancock and Unicoi Counties is fewer than 10, meaning that the statistics based on these counts are very unstable. The highest percentage of fentanyl deaths occurred in Greene County, where 70.0% of drug deaths involved fentanyl.

The highest fentanyl mortality rate was also in Greene County, at 32.2 fentanyl-involved deaths per 100,000 residents, followed by Sullivan County, at 28.6 deaths per 100,000 residents. No rate was tabulated for Hancock or Unicoi Counties due to counts below 10.

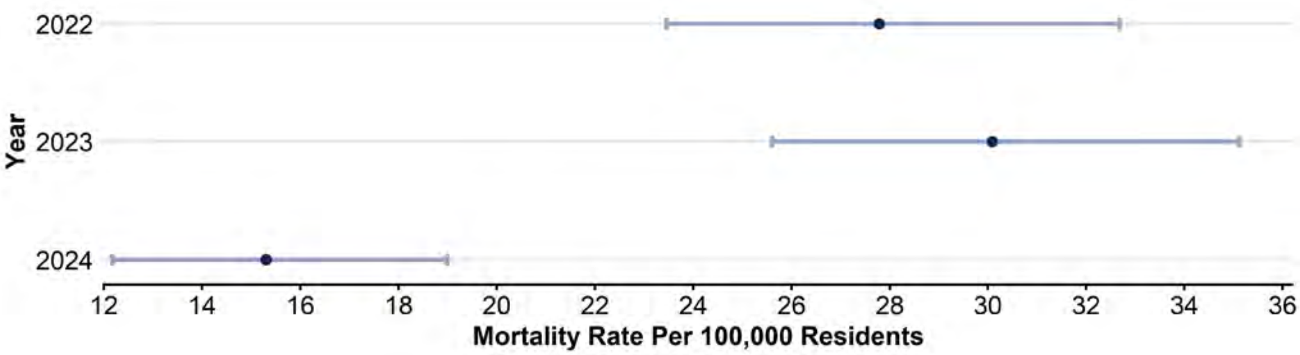
Map 4.2 Fentanyl-Involved Percentage by County, 2022-2024 (N = 388)



Map 4.2 above shows the percentages of drug deaths that involved fentanyl for each county from 2022 to 2024 for visual comparison with Table 4.4. We have displayed percentages instead of mortality rates because not all counties have calculable rates.

As in previous sections, it is also useful to look at the fluctuation in fentanyl-involved deaths by year. From 2022 to 2023, there was a slight increase in the total number, but in 2024, there was a substantial decrease (48.8% drop from 2023 to 2024). It is useful to examine these changes using mortality rates with confidence intervals, as shown in Fig 4.8 on the next page.

Fig 4.8 Fentanyl-Involved Mortality Rate by Year, 2022-2024 (N = 388)



We can see substantial overlap in the 95% confidence intervals associated with the rates in 2022 and 2023, meaning that even though the calculated rates are slightly different, we cannot conclude that the difference is statistically significant.

The fentanyl-involved mortality rate in 2024 is significantly lower than either previous year, as indicated by the confidence intervals shown. This suggests that the decrease in overall drug-related deaths might be driven to a certain extent by a corresponding decrease in fentanyl mortality. Additional data years will help clarify this potential effect.

Fig 4.9 shows the percentage breakdown of fentanyl-involved deaths by manner. While we have seen that overall, the majority of drug-related deaths are accidental in manner (95.4%), the percentage of accidental fentanyl deaths is even higher (98.7%). This difference is statistically significant, verified using chi-square testing.

Figure 4.9 Fentanyl-Involved Deaths by Manner, 2022-2024 (N = 388)

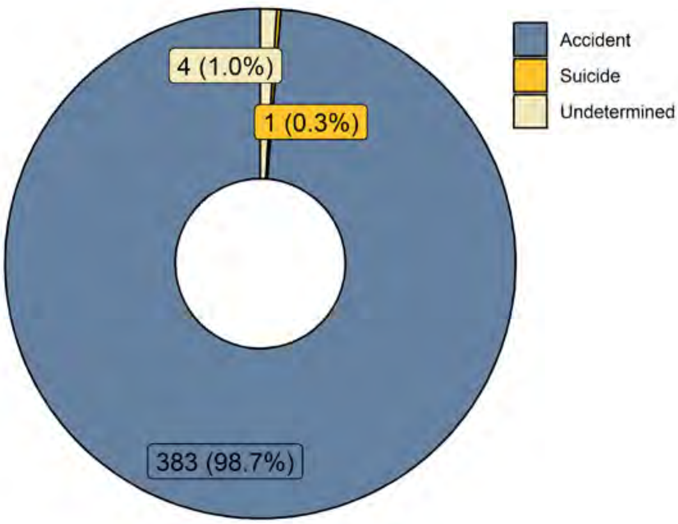


Table 4.5 below shows the percentage and mortality rate calculations for fentanyl-involved deaths aggregated across all years. Mortality rates that are significantly lower from non-fentanyl rates are shown either in bold (higher) or italics (lower).

Table 4.5 Fentanyl-Involved Mortality Rates by Demographic, 2022-2024 (N = 388)

	Count	Percent	Rate Per 100,000 Residents	95% CI
Sex				
Male†	276	71.1	**35.0**	**31.0 - 39.4**
Female	112	28.9	13.9	11.4 - 16.7
Race				
White	356	91.8	23.8	21.4 - 26.4
Black	31	8.0	70.7	48.0 - 100.3
Other*	1	0.3	*	*
Ethnicity				
Not Hispanic	383	98.7	*	*
Hispanic	5	1.3		*
Age at Death				
Below 18 years	3	0.8	*	*
18-24 years†	36	9.3	**25.2**	**17.7 - 34.9**
25-34 years†	88	22.7	**45.1**	**36.1 - 55.5**
35-44 years†	114	29.4	**63.2**	**52.1 - 75.9**
45-54 years	85	21.9	41.3	33.0 - 51.1
55-64 years§	44	11.3	*19.3*	*14.0 - 25.9*
65+ years§	18	4.6	*5.2*	*3.1 - 8.2*

*Aggregated category includes Asian and unspecified Other racial classifications

† Fentanyl-involved mortality rate is significantly higher than non-fentanyl mortality rate

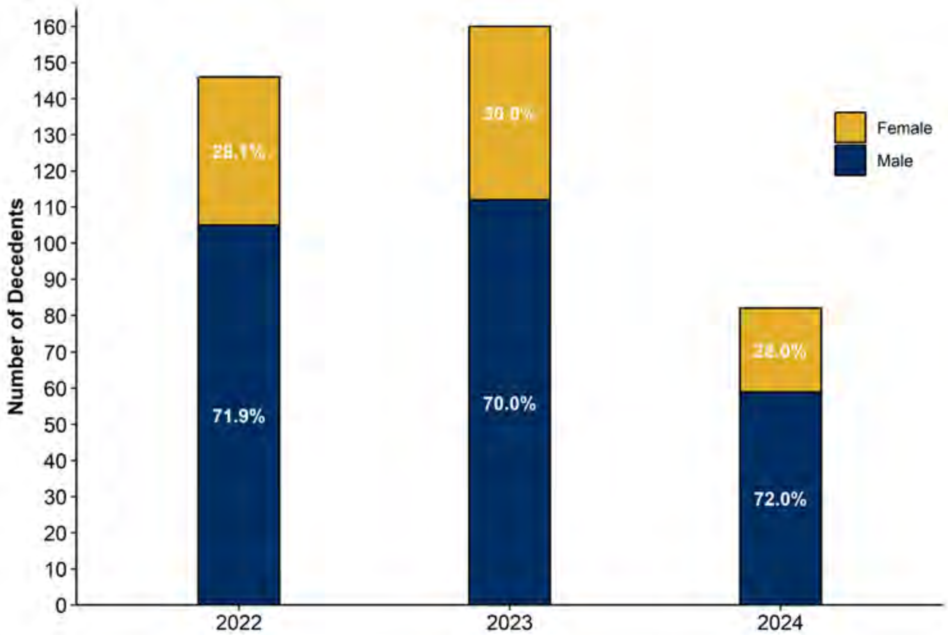
§ Fentanyl-involved mortality rate is significantly lower than non-fentanyl mortality rate

The majority of decedents are male compared to female; chi-square testing shows that the proportion of male to female decedents in fentanyl deaths is significantly higher than non-fentanyl deaths. While 71.1% of fentanyl-involved deaths are male decedents, only 58.5% of non-fentanyl deaths are male decedents. Interestingly, this percentage difference for fentanyl-involved deaths is quite stable, as shown in Fig 4.10 on the next page. In this figure, we can clearly see that the percentage of male decedents in all years is consistently around 70%.

We also see that when we compare the mortality rates between these groups, the rate of fentanyl-involved deaths for males is higher than for non-fentanyl deaths, and this difference is statistically significant. There is no difference between the rates for fentanyl vs. non-fentanyl female deaths.

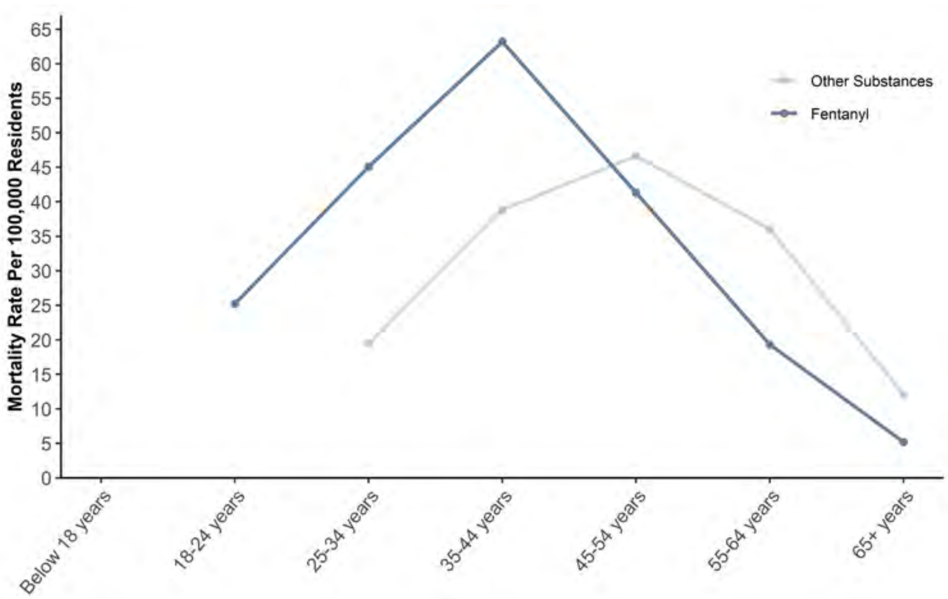
When looking at the proportion of decedents across racial groups, chi-square testing does *not* find a significant difference, meaning that the proportion of white decedents to black decedents is similar for fentanyl-involved deaths compared to non-fentanyl deaths. There is also no difference between the fentanyl vs. non-fentanyl mortality rates for either black or white decedents.

Figure 4.10 Fentanyl-Involved Decedent Sex by Year, 2022-2024 (N = 388)



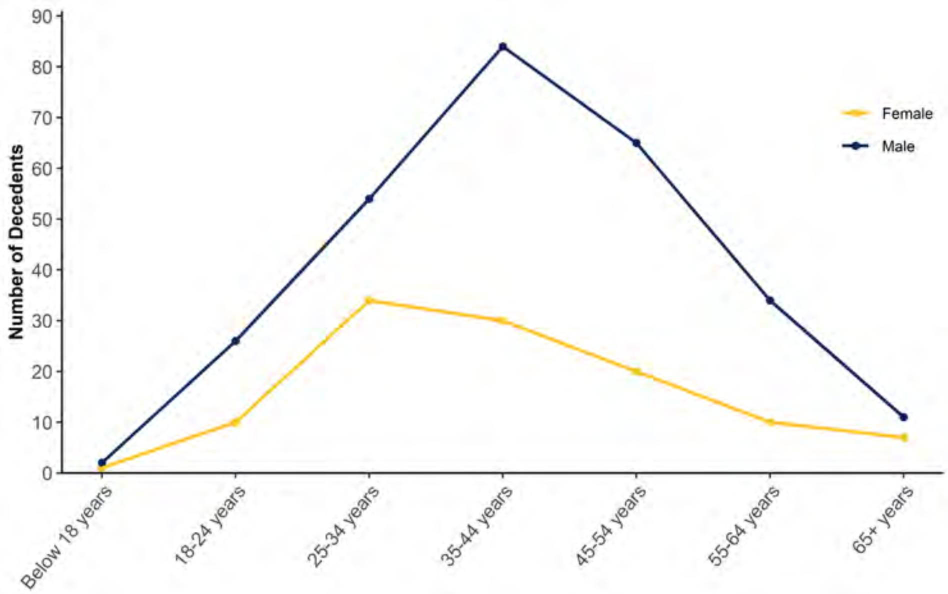
On average, fentanyl-involved deaths have a lower age at death compared with non-fentanyl deaths: 41.1 years for fentanyl deaths compared to 49.7 years otherwise. This difference is statistically significant, although additional testing indicates that the overall age distributions are not significantly different. While the rates shown in Table 4.5 show clearly that the scale of the distributions is different, we can see in Fig 4.11 below that the shapes of each distribution are relatively similar. This similarity in shape is what the statistical testing is looking at, which is why it finds no meaningful difference there.

Figure 4.11 Mortality Rates by Age at Death by Substance Type, 2022-2024 (N = 725)



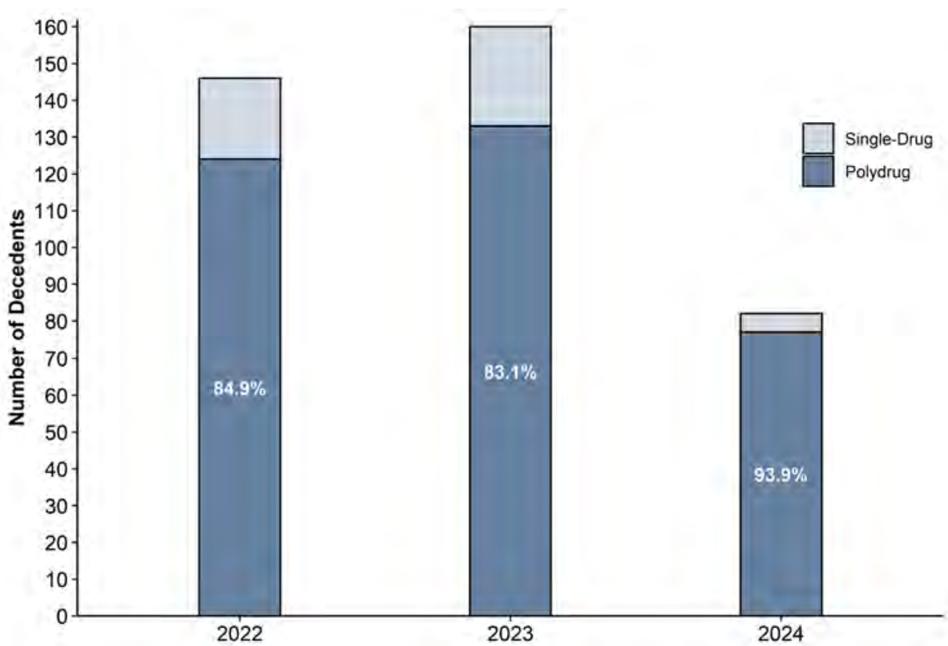
As in the previous section, we are also interested in differences by sex. Fig 4.12 shows the age distribution of fentanyl-involved deaths by sex. Again, this is count data rather than rate data; several age categories by sex have fewer than 10 decedents, so we cannot calculate rates for all categories. On average, male decedents are slightly older than female decedents: 41.7 years old for male decedents compared to 39.8 years old for female decedents. This difference is not statistically significant. Statistical tests comparing the shapes of the two distributions suggest that there may be some difference by sex in fentanyl-involved deaths; additional data years are needed.

Figure 4.12 Fentanyl-Involved Deaths by Age by Sex, 2022-2024 (N = 388)



Finally, we turn our attention to the other potential substances contributing to fentanyl-involved deaths. Overall, 86.1% of fentanyl-involved deaths are polydrug, meaning that one or more additional substances were listed by the certifier as contributing to death. This percentage has increased from 2022 to 2024, as shown in Fig 4.13. A much lower percentage of non-fentanyl deaths are polydrug (35.6%); chi-square testing verified that this difference is statistically significant.

Figure 4.13 Fentanyl-Involved Polydrug Deaths by Year, 2022-2024 (N = 388)



We looked at the number of substances positive on the toxicology results for fentanyl-involved deaths, as well as the total number of substances stated as contributing to death. Fentanyl-involved deaths have an average of 2.67 substances contributing to death compared to 1.78 substances contributing to death in all other cases. This difference is statistically significant, although there is not an overall effect in the available data. When we look at the overall distribution of number of contributing substances, there is no difference between fentanyl-involved deaths and non-fentanyl deaths apart from the average. The distributions are statistically the same otherwise.

Now we look at the specific substances themselves. Table 4.6 below lists the most common substances present in polydrug fentanyl-involved deaths for five or more decedents. About sixty-five percent (65.3%) of polydrug fentanyl deaths also involved methamphetamine. No other substance was present to that high a degree; the next most common substance was 4-ANPP, a fentanyl precursor, present in 12.3% of polydrug fentanyl deaths.

Table 4.6 Additional Substances in Polydrug Fentanyl Deaths, 2022-2024 (N = 334)

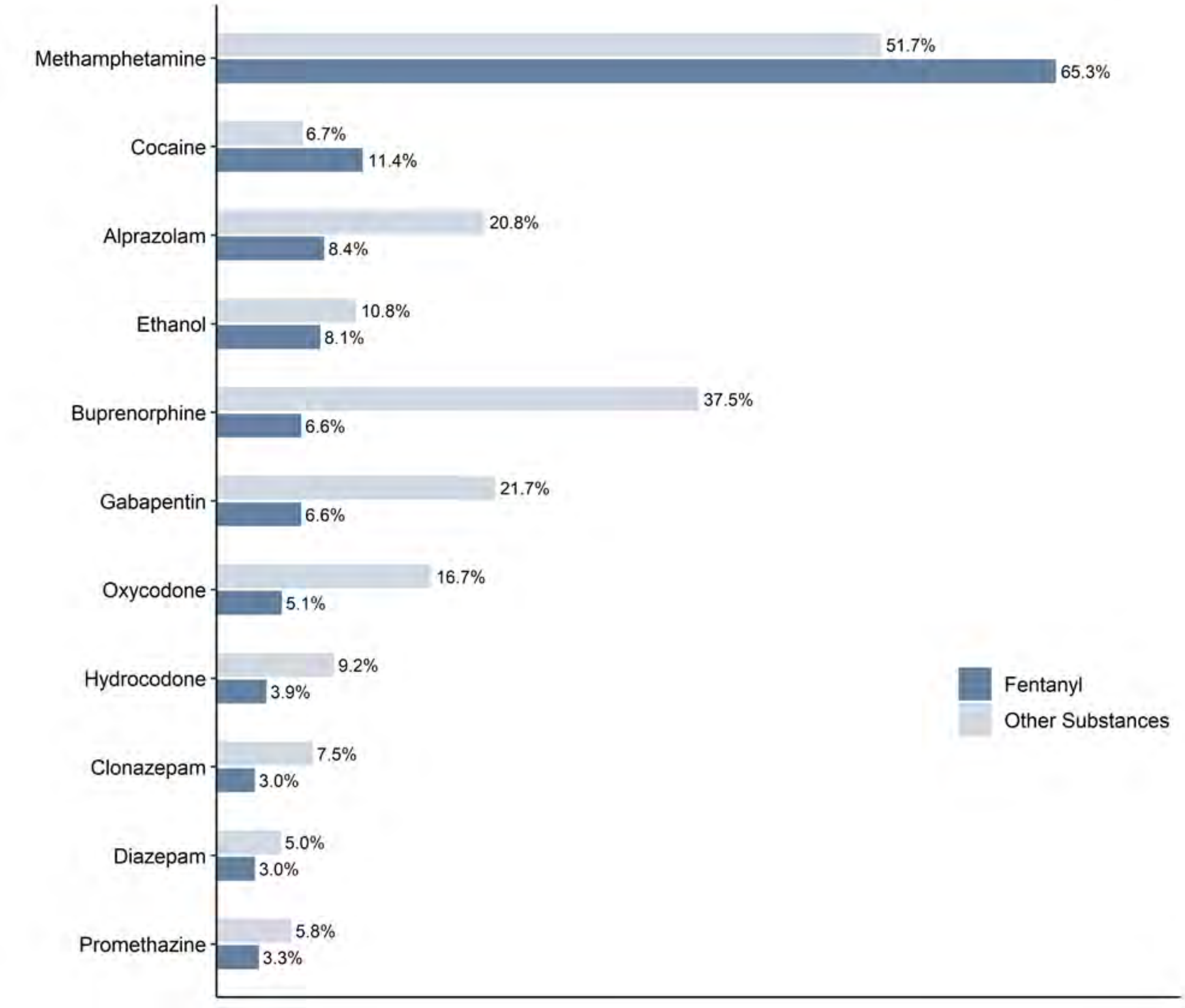
	Count	Percent
Methamphetamine	218	65.3
4-ANPP	41	12.3
Cocaine	38	11.4
Xylazine	34	10.2
Alprazolam	28	8.4
Ethanol	27	8.1
para-Fluorofentanyl	24	7.2
Buprenorphine	22	6.6
Gabapentin	22	6.6
Oxycodone	17	5.1
Acetyl Fentanyl	13	3.9
Hydrocodone	13	3.9
Mitragynine	11	3.3
Promethazine	11	3.3
Clonazepam	10	3.0
Diazepam	10	3.0
6-Monoacetylmorphine	9	2.7
Bromazolam	9	2.7
Diphenhydramine	9	2.7
Hydroxyzine	7	2.1
7-Amino Clonazepam	6	1.8
Morphine	6	1.8
Methadone	5	1.5
Nordiazepam	5	1.5
Oxymorphone	5	1.5
Total Number of Decedents	334	

Fig 4.14 compares these percentages to the percentages of non-fentanyl polydrug deaths involving the same substances. Methamphetamine and cocaine are substantially more common in fentanyl polydrug deaths compared to non-fentanyl polydrug deaths. All other substances shown in the figure are substantially more common in non-fentanyl deaths.

We note that many of the substances listed in Table 4.6 that are not shown in Fig 4.14 are actually fentanyl analogs or precursors: 4-ANPP, para-fluorofentanyl, and acetyl fentanyl. These substances cannot be present in non-fentanyl deaths due to the nature of how they metabolize.

The only substance present in a high percentage of non-fentanyl polydrug deaths not shown in Fig 4.14 is diphenhydramine, which is present in 15.0% of non-fentanyl deaths, compared to 2.7% of fentanyl polydrug deaths, as shown in Table 4.6.

Figure 4.14 Additional Substances in Polydrug Deaths, 2022-2024 (N = 454)



Benzodiazepine-Involved Deaths

From 2022 to 2024, there were 110 decedents reported to WLJFC with one or more benzodiazepines listed as a substance contributing to death. About fifteen percent of drug-related deaths (15.2%) involved a benzodiazepine, and the associated mortality rate of benzodiazepine-involved deaths in this time period is 6.9 deaths per 100,000 residents.

The majority of these deaths (63 cases, 57.3%) occurred in non-jurisdictional counties, and the remaining 47 (42.7%) occurred in jurisdictional counties. Table 4.7 shows county-level statistics for fentanyl-involved deaths, including percentages and rates.

Table 4.7 Benzodiazepine-Involved Mortality Rates by County, 2022-2024 (N = 110)

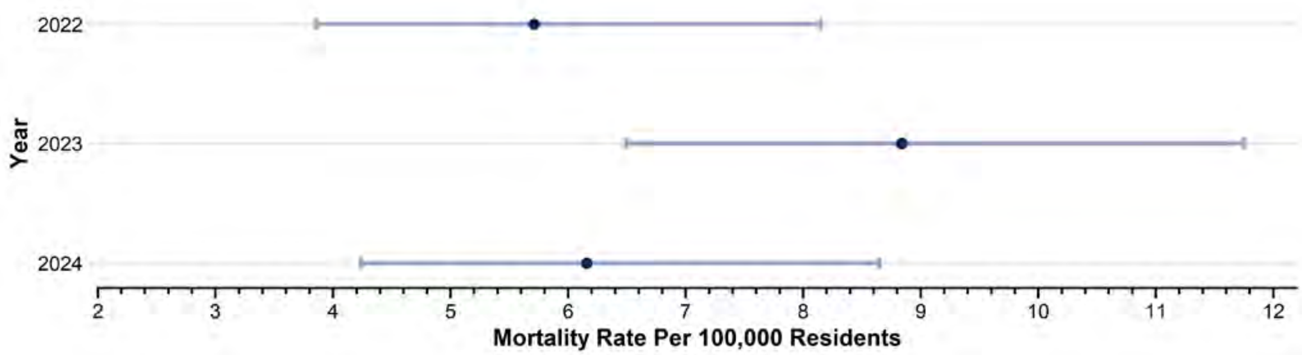
	Fentanyl Death Count	Percentage of Drug Deaths	Mortality Rate Per 100,000 Residents	95% CI
Jurisdictional Counties				
Carter	7	9.5	*	*
Johnson	3	10.0	*	*
Unicoi	4	25.0	*	*
Washington	33	15.8	8.0	5.5 - 11.2
Non-Jurisdictional Counties				
Greene	13	13.0	6.0	3.2 - 10.2
Hancock	2	15.4	*	*
Hawkins	7	18.9	*	*
Sullivan	41	16.7	8.4	6.1 - 11.5
Total	110	15.2	6.9	5.7 - 8.3

The percentage of drug-related deaths involving a benzodiazepine is relatively consistent across all counties, although we note that only three counties had more than 10 deaths, so as in previous sections, we remind the reader that these statistics are unstable. Sullivan County had the highest benzodiazepine-involved mortality rate, at 8.4 deaths per 100,000 residents, accounting for 16.7% of drug-related deaths reported to WLJFC.

While the number of benzodiazepine-involved deaths reported to WLJFC is smaller than the number of deaths involving either methamphetamine or fentanyl, we include statistics for benzodiazepine deaths because, unlike those other substances, the number of deaths has remained steady across all data years, even though the overall number of drug-related deaths has decreased. This difference means that the trends among this population are potentially valuable for prevention insights.

Fig 4.15 shows the changes in mortality rates with 95% confidence intervals from 2022 to 2024. We can see that the confidence intervals associated with each yearly rate overlap substantially, meaning that even though the calculated rates are slightly different in each year, we cannot conclude that the difference is statistically significant.

Fig 4.15 Benzodiazepine-Involved Mortality Rate by Year, 2022-2024 (N = 110)



This stable mortality rate means that even as the number of yearly benzodiazepine-involved deaths stays relatively consistent, the *proportion* of deaths reported to WLJFC that involve one or more benzodiazepines increases as the total number of drug-related deaths decreases. Fig 4.16 shows how this is represented in our dataset; the height of the benzodiazepine-involved bars is the same in 2022 and 2024, but in 2022, that bar represents 11.7% of all drug-related deaths, while in 2024, that count now represents 19.4% of drug-related deaths.

Figure 4.16 Benzodiazepine-Involved Deaths by Year, 2022-2024 (N = 725)

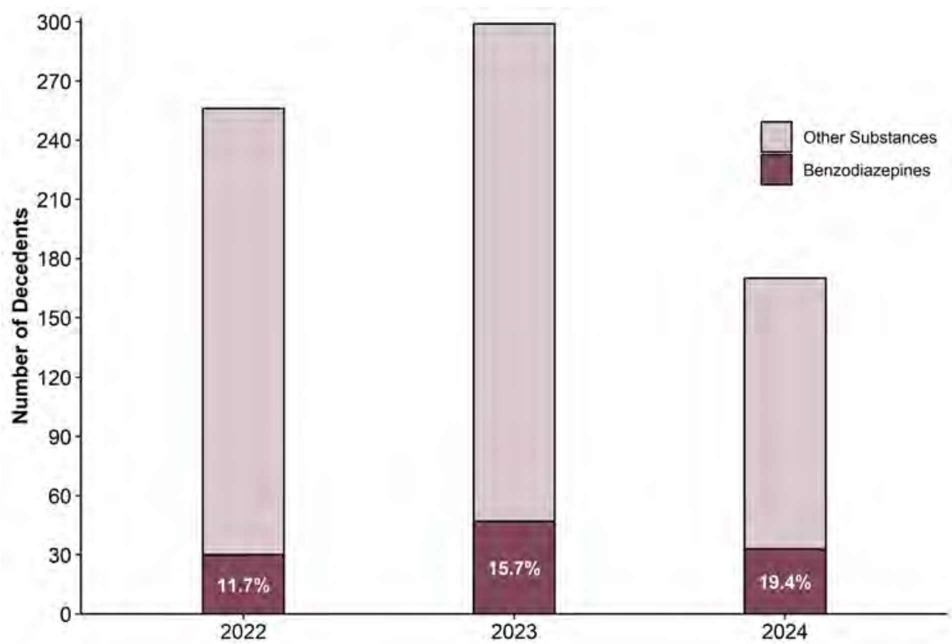


Fig 4.17 shows the percentage of benzodiazepine-involved deaths by manner. While the majority of deaths are accidental in manner (91.8%), this percentage is lower than the percentage of non-benzodiazepine accidental deaths (96.1%). Chi-square testing verifies that this difference is statistically significant.

Figure 4.17 Benzodiazepine-Involved Deaths by Manner, 2022-2024 (N = 110)

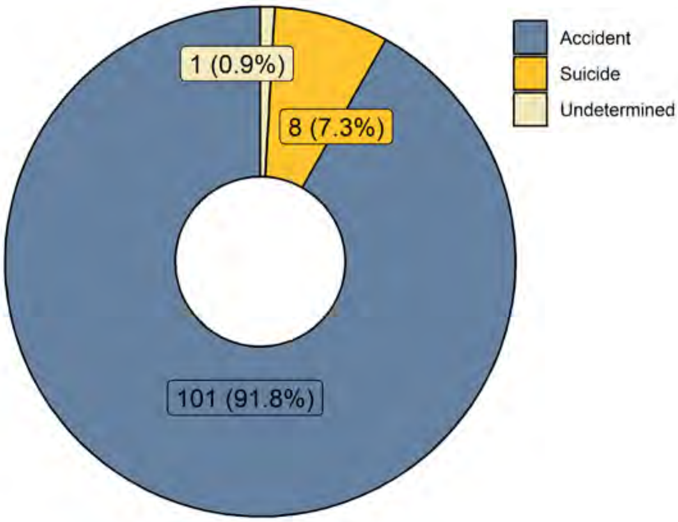


Table 4.8 below shows truncated demographic statistics for benzodiazepine-involved deaths. Race and ethnicity statistics are not shown; all 110 decedents were non-Hispanic, and 109 decedents were white. Mortality rates with confidence intervals are provided when appropriate, but they are not compared to non-benzodiazepine deaths; all of them are significantly lower. We are interested in comparing trends here, not rates.

Table 4.8 Benzodiazepine-Involved Mortality Rates by Demographic, 2022-2024 (N = 110)

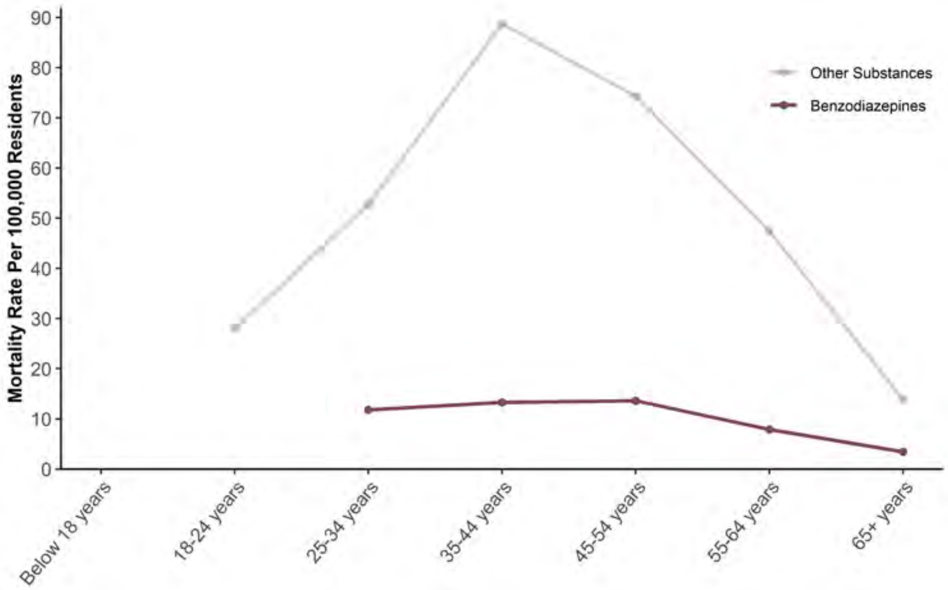
	Count	Percent	Rate Per 100,000 Residents	95% CI
Sex				
Male	68	61.8	8.6	6.7 - 10.9
Female	42	38.2	5.2	3.8 - 7.0
Age at Death				
Below 18 years	1	0.9	*	*
18-24 years	4	3.6	*	*
25-34 years	23	20.9	11.8	7.5 - 17.7
35-44 years	24	21.8	13.3	8.5 - 19.8
45-54 years	28	25.5	13.6	9.0 - 19.7
55-64 years	18	16.4	7.9	4.7 - 12.5
65+ years	12	10.9	3.4	1.8 - 6.0

The majority of decedents are male compared to female, but this difference is lower than for either methamphetamine-involved or fentanyl-involved deaths. Chi-square testing shows that the proportion of male to female decedents in benzodiazepine deaths is not significantly different from non-benzodiazepine deaths: 61.8% of benzodiazepine-involved deaths are male decedents compared to 65.8% of non-benzodiazepine deaths.

Due to relatively small counts in all age groups, we will keep our discussion of differences between benzodiazepine-involved deaths and non-benzodiazepine deaths brief. Interestingly, however, we observe that the average age at death between these groups is remarkably similar: benzodiazepine-involved deaths are 45.5 years old on average, compared to 45.0 years old for non-benzodiazepine deaths.

Despite the fact that the averages are so similar, there is some evidence that the age distributions of these groups differs. Again, more data is needed to present more stable statistics for benzodiazepine-involved rates, but we can see in Fig 4.18 below that there is not a distinct peak in the distribution for benzodiazepine-involved deaths. The rate is very similar from 25 to 54 years. In the non-benzodiazepine mortality rate, we see a sharp peak at 35 to 44 years.

Figure 4.18 Mortality Rates by Age at Death by Substance Type, 2022-2024 (N = 725)



We complete our discussion of benzodiazepine-involved deaths by looking at the substances involved. Fatal overdose on a single benzodiazepine is extremely uncommon; the overwhelming majority of drug-related deaths involving a benzodiazepine are polydrug in nature. We observe this in our own data as well – the one single-drug benzodiazepine death also had a complex medical history with several contributing causes.

We also observe a substantial difference in the number of positive substances contributing to death. Benzodiazepine-involved deaths have an average of 4.00 substances contributing to death compared to 1.94 substances for non-benzodiazepine deaths. This difference is statistically signficant.

Because we are discussing a class of multiple substances, Table 4.9 on the next page shows information about the specific benzodiazepines present. Almost half of benzodiazepine-involved deaths (48.2%) list alprazolam as contributing to death. Clonazepam (17.3%) and diazepam (14.5%) were also commonly present, as well as the designer benzodiazepine bromazolam (12.7%).

Table 4.9 Benzodiazepines Contributing to Death, 2022-2024 (N = 110)

	Count	Percent
Prescription		
Alprazolam	53	48.2
Chlordiazepoxide	1	0.9
Clonazepam	19	17.3
Diazepam	16	14.5
Lorazepam	3	2.7
Temazepam	2	1.8
Illicit		
Bromazolam	14	12.7
Etizolam	2	1.8
Metabolite		
7-Amino Clonazepam	9	8.2
Nordiazepam	6	5.5

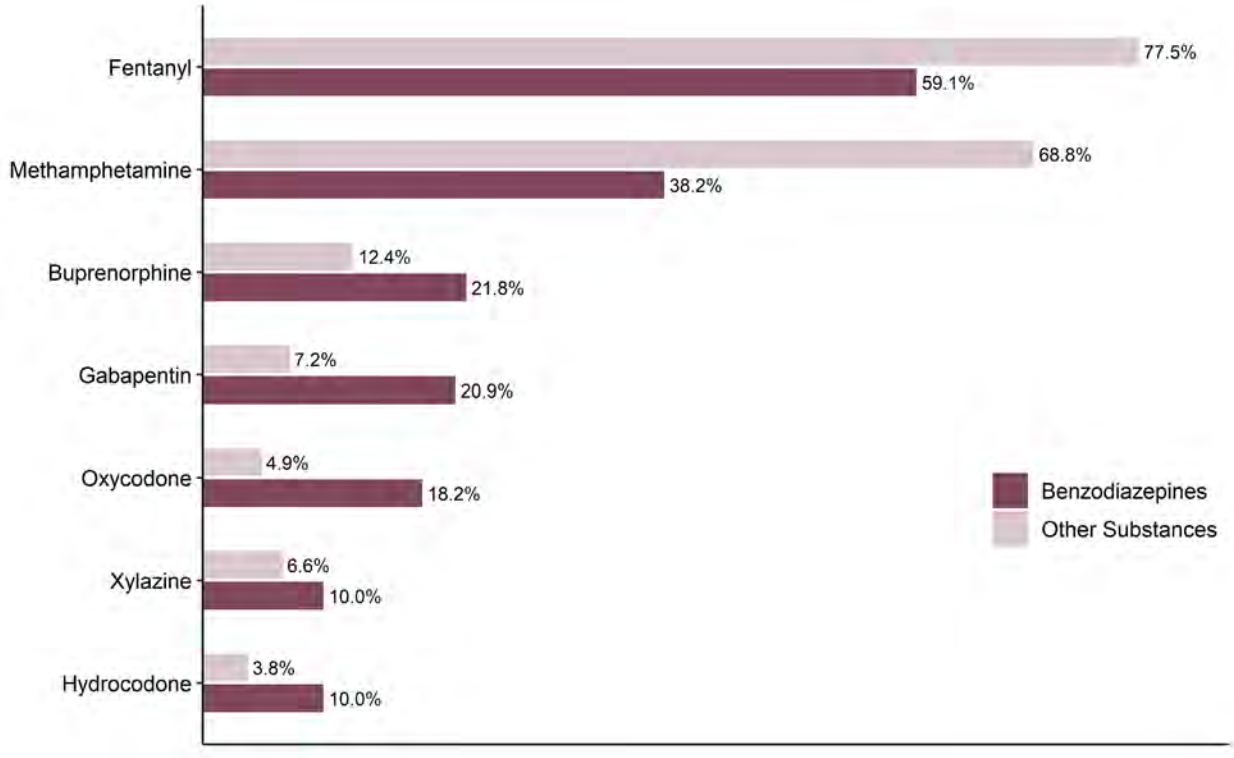
Table 4.10 lists additional substances present in benzodiazepine-involved deaths. The most common substance was fentanyl (59.1%), followed by methamphetamine (38.2%) and buprenorphine (21.8%). We note that there is a wider variation in substances here compared to substances present in methamphetamine-involved or fentanyl-involved deaths. In those categories, there tended to be a single prevalent substance and relatively low percentages of all others, but Table 4.10 shows a different pattern.

Fig 4.19 on the next page compares these percentages to the percentage of non-benzodiazepine polydrug deaths with those substances present. We see that fentanyl and methamphetamine were more common in non-benzodiazepine deaths, but all other substances shown were more common in benzodiazepine-involved deaths.

Table 4.10 Additional Substances in Benzodiazepine-Involved Deaths, 2022-2024 (N = 110)

	Count	Percent
Fentanyl	65	59.1
Methamphetamine	42	38.2
Buprenorphine	24	21.8
Gabapentin	23	20.9
Oxycodone	20	18.2
Promethazine	14	12.7
Hydrocodone	11	10.0
Xylazine	11	10.0
Cocaine	9	8.2
Diphenhydramine	9	8.2
Hydroxyzine	8	7.3
Amitriptyline	6	5.5
para-Fluorofentanyl	6	5.5
4-ANPP	5	4.5
Cyclobenzaprine	5	4.5

Figure 4.19 Additional Substances in Polydrug Deaths, 2022-2024 (N = 454)



Buprenorphine-Involved Deaths

From 2022 to 2024, there were 70 decedents reported to WLJFC with buprenorphine listed as a substance contributing to death. About ten percent of drug-related deaths (9.7%) involved a buprenorphine, and the associated mortality rate of buprenorphine-involved deaths in this time period is 4.4 deaths per 100,000 residents.

The majority of these deaths (42 cases, 60.0%) occurred in non-jurisdictional counties, and the remaining 28 (40.0%) occurred in jurisdictional counties. We do not present county-specific counts here because they are too low for meaningful interpretation; six of the eight counties have fewer than 10 buprenorphine-involved deaths in our dataset. We do note that 7.2% of drug-related deaths (15 cases) in Washington County and 12.6% of drug-related deaths in Sullivan County (31 cases) involved buprenorphine.

The buprenorphine-involved mortality rate is also relatively consistent from 2022 to 2024, as shown in Fig 4.20 on the next page. The confidence intervals associated with each yearly rate overlap substantially, meaning that even though the calculated rates are slightly different in each year, we cannot conclude that the difference is statistically significant.

Fig 4.20 Buprenorphine-Involved Mortality Rate by Year, 2022-2024 (N = 70)

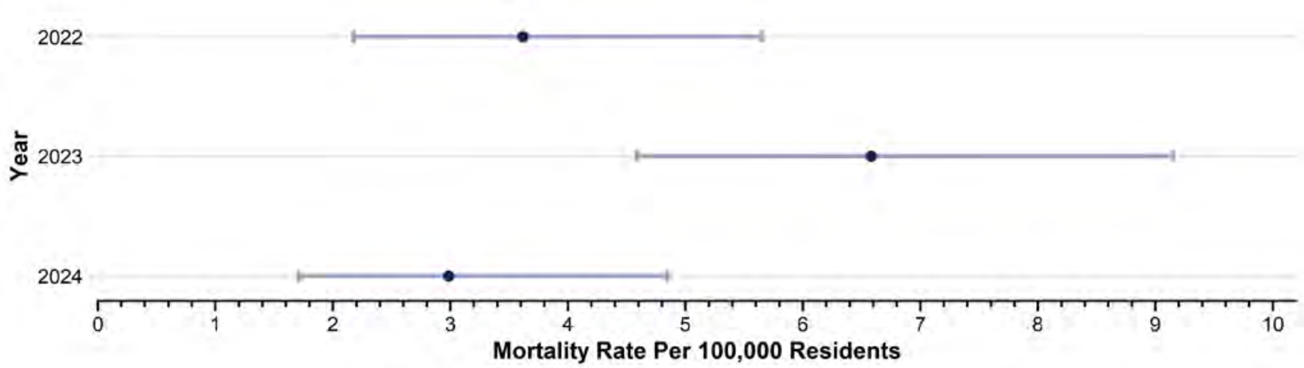


Fig 4.21 shows the percentage of buprenorphine-involved deaths by manner. Unlike all previous substance-specific manner comparisons, despite the fact that the percentage of accidental buprenorphine-involved deaths (98.6%) is higher than accidental non-buprenorphine deaths (95.1%), this difference is not statistically significant.

Figure 4.21 Buprenorphine-Involved Deaths by Manner, 2022-2024 (N = 70)

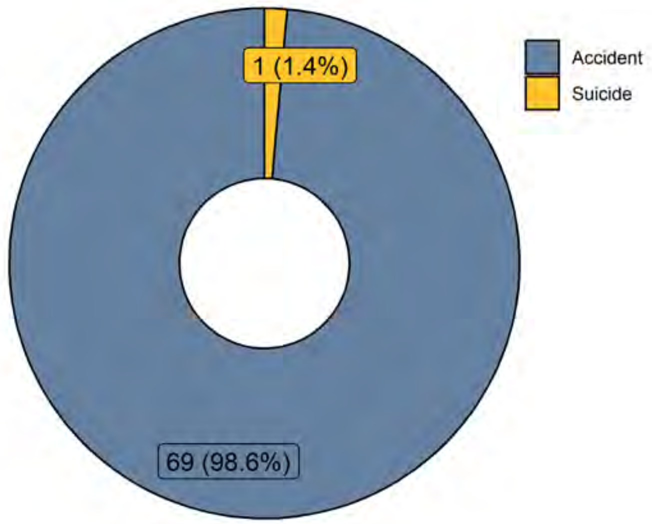


Table 4.11 below shows truncated demographic statistics for buprenorphine-involved deaths. Race and ethnicity statistics are not shown; all 70 decedents were non-Hispanic, and 69 decedents were white.

Table 4.11 Buprenorphine-Involved Mortality Rates by Demographic, 2022-2024 (N = 70)

	Count	Percent	Rate Per 100,000 Residents	95% CI
Sex				
Male	41	58.6	5.2	3.7 - 7.1
Female	29	41.4	3.6	2.4 - 5.2
Age at Death				
Below 18 years	0	0.0	*	*
18-24 years	1	1.4	*	*
25-34 years	10	14.3	5.1	2.5 - 9.4
35-44 years	21	30.0	11.6	7.2 - 17.8
45-54 years	10	14.3	4.9	2.3 - 8.9
55-64 years	18	25.7	7.9	4.7 - 12.5
65+ years	10	14.3	2.9	1.4 - 5.3

The majority of decedents are male compared to female, but this difference is the lowest of all substance-specific testing presented in this report. Chi-square testing shows that the proportion of male to female decedents in buprenorphine deaths is not significantly different from non-buprenorphine deaths: 58.6% of buprenorphine-involved deaths are male decedents compared to 66.0% of non-buprenorphine deaths.

The counts in all age groups are sufficiently small that even when rates are calculable, they are not stable, so we simply note that on average, buprenorphine-involved deaths have a higher age at death compared with non-buprenorphine deaths: 48.8 years for buprenorphine deaths compared to 44.7 years otherwise. The confidence intervals associated with these values overlap very slightly, meaning that we cannot conclude that these values are statistically different. But we note that is likely due to how small the total count of buprenorphine-involved deaths is. With additional data years, it is highly likely that this analysis will change.

We now turn our attention to the additional substances contributing to buprenorphine-involved deaths. Single-drug buprenorphine deaths are very uncommon; 69 of the 70 deaths in our dataset were polydrug, and the one single-drug buprenorphine death also had contributing medical conditions.

On average, buprenorphine-involved deaths have a higher number of positive substances contributing to death than non-buprenorphine deaths: an average of 3.37 substances in buprenorphine deaths compared to 2.14 substances otherwise. This difference is statistically significant.

In our discussion on specific contributing substances, it is important to keep in mind that buprenorphine is commonly prescribed as a medication for opioid use disorder (MOUD). When used as an MOUD, buprenorphine can be prescribed in combination with gabapentin and a benzodiazepine such as alprazolam or clonazepam. Ten percent (10.0%) of buprenorphine-involved deaths had positive toxicology results for this combination of substances; all seven of these decedents were positive for additional non-MOUD substances.

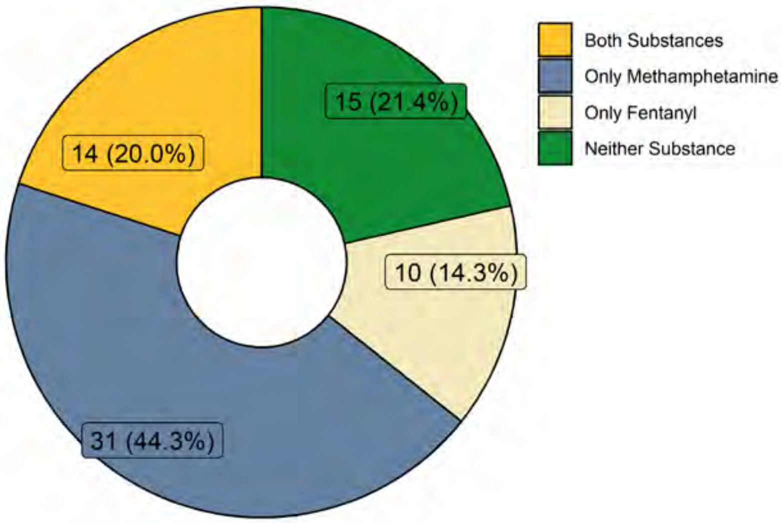
Table 4.12 lists additional substances present in buprenorphine-involved deaths. The most common substance was methamphetamine (62.9%), followed by fentanyl (32.9%) and alprazolam (21.4%).

Table 4.12 Additional Substances in Buprenorphine-Involved Deaths, 2022-2024 (N = 70)

	Count	Percent
Methamphetamine	44	62.9
Fentanyl	23	32.9
Alprazolam	15	21.4
Gabapentin	13	18.6
Cocaine	6	8.6
Diazepam	5	7.1
Promethazine	5	7.1
Bromazolam	4	5.7
Ethanol	4	5.7
Oxycodone	4	5.7
Clonazepam	3	4.3
Xylazine	3	4.3

Comparison to non-buprenorphine deaths is not as useful here; the small overall count of buprenorphine-involved deaths can make such a comparison difficult to interpret. Instead, we turn our attention to the role that methamphetamine and fentanyl play in these cases. Fig 4.22 shows the proportion of buprenorphine-involved deaths where the decedent also listed methamphetamine or fentanyl as contributing.

Figure 4.22 Methamphetamine and Fentanyl in Buprenorphine-Involved Deaths, 2022-2024 (N = 70)



Almost seventy-nine percent (78.6%) of buprenorphine-involved deaths also listed either methamphetamine or fentanyl as a contributing substance. Five of the seven decedents with toxicology positive for the three MOUD substances discussed above are included in this percentage.

Report Preparation

This report was prepared using a dataset generated in MDILog on June 28, 2025. SAS and R were used to tabulate statistics and prepare figures, and all maps were created in ArcGIS using the geocoding database maintained by the TN STS-GIS division. All other sources are cited by footnote in the text above.

If there are any questions about the William L. Jenkins Forensic Center and its operations, please contact Laura Beth Parsons. If there are any questions about the statistics or methods used to generate this report, please contact Molly Golladay.

Report prepared by:

Laura Beth Parsons, F-ABMDI
Director of Operations
William L. Jenkins Forensic Center
(423) 439-6788
parsonsl@etsu.edu

Molly Golladay
Epidemiologist II
Tennessee Office of the State Chief Medical Examiner
(615) 339-3163
molly.golladay@tn.gov

Appendix A. Death Certificate Classification

The majority of mortality statistics are generated using the cause and manner of death stated on the official death certificate. As stated in Section I, certificates are standardized using the International Classification of Disease, 10th revision (ICD-10)*. This standardization process is quite complex, and while it is not our intention to go into much detail here†, a brief overview is helpful.

After a death certificate is completed, the information on cause of death, manner, and how the injury occurred (if relevant) are 'read' via computational algorithm. The algorithm then generates a series of ICD-10 codes intended to be a transliteration of the certificate text. Those ICD-10 codes are compared to a series of decision tables to determine which specific code is the *underlying* cause; it is typically this underlying code that is used as the official cause of death for mortality statistics. In a very small percentage of cases, the algorithm is unable to 'read' the certificate; in these situations, a person called a nosologist manually generates the necessary codes.

This process means that there is always a layer of interpretation between the certifier who wrote the cause text and the ICD-10 code of official record. The cause-of-death text can be written in such a way that the algorithm does not 'pick' the cause of death that the certifier intended, and in those cases, the statistics involving that particular case would be different depending on the data source used.

We can never state with any certainty the number of cases where this has occurred, although in the majority of deaths certified by a medical examiner's office, the cause of death tends to be more apparent than not. In many natural deaths which are **not** certified by an ME, the decedent can have multiple co-morbidities listed on a certificate that can make determining a single underlying cause more complex. It is quite likely, however, that the percentage of ME-certified cases where there may be a discrepancy between certifier intent and the generated ICD-10 code is extremely low. We mention it here only because it can theoretically be part of why the count of deaths due to any cause can differ slightly depending on data source.

When using ICD-10 codes generated from death certificate data, drug-related deaths are defined as follows:

- *Accident*: X40-X44
- *Suicide*: X60-X64
- *Homicide*: X85
- *Undetermined intent*: Y10-Y14

These codes are all associated with death due to "poisoning," which is the phrase preferred by the ICD. There are secondary codes associated with different substances. For example, if a cause of death is listed as "acute fentanyl and methamphetamine toxicity" with a manner of accident, three ICD-10 codes will be generated: X44 to indicate poisoning, T40.4 to indicate a synthetic narcotic (fentanyl), and T43.6 to indicate a stimulant (methamphetamine). Substance codes often indicate classes of substances rather than specific substances, so literal text searching is commonly used to generate counts of specific drugs.

* Full description available at https://icd.who.int/browse10/2019/en

† All manuals describing the process of generating ICD-10 cause codes are available at https://www.cdc.gov/nchs/nvss/instruction-manuals.htm

To complete our discussion of mortality statistics using death certificate data, we remind the reader that in Section I of this report, it was mentioned that most public health datasets are based on residency. What that means is that when most agencies are generating counts/mortality rates related to specific causes of death, they are grouping the death certificates according to the decedent's **residence** information listed on the certificate. As discussed in Section I, this is usually done to ensure that the calculation of mortality rates can use US Census data, which is based on residency.

In medical examiner data, we generate our information based on the decedent's **death** location*, regardless of residency. This means that we include cases where the decedent died in one of our service counties but did not live there. It also means that we exclude cases where a person who lived in one of our service counties died outside of our jurisdiction. While in the majority of cases, the county of residence and county of death are the same, it is not always. Counties that contain a large hospital with a trauma center often have a higher percentage of non-resident deaths, for example.

While these geographical nuances don't impact how an individual death certificate is assigned an ICD-10 code, when working with mortality data, it is always important to check and see if the case definition is based on **residency** or **occurrence** (i.e., location of death), because those counts will almost always be different.

When dealing with the specific dataset generated using WLJFC data, we must also bear in mind that for four of our eight service counties (Greene, Hancock, Hawkins, and Sullivan), not all ME-certified deaths are sent to WLJFC. In these counties, WLJFC only includes cases sent for autopsy/exam, so there is also the potential that the medical examiners of these counties certified drug-related deaths without ordering services from WLJFC, meaning that even the occurrence counts may differ. This is why we have specified counts based on "deaths reported to WLJFC" throughout the report. In non-jurisdictional counties, the MEs may certify deaths without reporting to WLJFC.

Mortality data can be complex to define, which is why it is useful to consider (1) the data source; i.e., if it is death certificate data or ME-generated data, (2) the case definition; i.e., which ICD-10 codes or text searching is used, and (3) the geographical parameters; i.e., whether it is residency or occurrence. This can help the reader understand why counts may differ from different sources, as well as how the specific information presented should be interpreted.

* In reality, it's slightly more complex than this. We actually group cases by the county of *service*, which is the county that ordered the autopsy/exam and is certifying the death. With very few exceptions, this is almost always the county of death. However, it should be noted that those rare exceptions exist, which is why even when grouping death certificate data by county of death, small discrepancies may still exist in some unusual circumstances.