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16. Abstract

Over the last few decades, interest in how drugs other than alcohol may be affecting roadway safety has increased. Studies conducted by NHTSA and others have provided substantial insights on the topic of drugged driving, but a gap in knowledge exists regarding drug prevalence among drivers and other road users such as pedestrians and bicyclists who are seriously or fatally injured in crashes in the United States. The current study sought to fill this gap by examining drug prevalence among a large sample ($N = 7{,}279$) of seriously injured roadway users presenting to seven selected trauma centers and fatally injured crash victims presenting directly to four medical examiners at selected sites. Overall, 55.8% of the injured or killed roadway users tested positive for one or more drugs (including alcohol) on this study's toxicology panel. The most prevalent drug category detected was cannabinoids (active THC) with 25.1% positive, followed by alcohol (23.1%), stimulants (10.8%), and opioids (9.3%). Overall, 19.9% of the roadway users tested positive for two or more categories of drugs. For drivers specifically, the results showed associations of drug positivity with age, sex, time of crash, and day of crash (weekday versus weekend). The results in this report provide a first look at drug prevalence among a large sample of seriously or fatally injured roadway users. This study's results can only be used to describe drug prevalence among the specific populations sampled and with full awareness of the study's limitations. The study results should not be used to imply impairment or increased risk associated with drug presence. Future similar research at these sites or others across the country could be used for monitoring changes in drugged driving over time and could inform traffic safety stakeholders to better tailor impaired driving countermeasures for particular regions or types of road users.

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Executive Summary

Background and Objective

Over the last few decades, there has been increased interest in how drugs other than alcohol may be affecting roadway safety due to several factors. First, in the United States the topic has gained prominence as an increasing number of States have legalized some form of cannabis consumption. Second, the "opioid epidemic" has prompted concerns that this class of drugs may be affecting drivers and other roadway users given large increases in use among the general public. Third, there are indications that prescription drug use is increasing. It is not fully understood how these changes may be affecting safety on America's roads. Determining whether these factors and others have translated to more drugged driving has required an expanded research focus that includes consideration of drugs other than alcohol.

The National Highway Traffic Safety Administration began testing for drugs other than alcohol as part of its 2007 National Roadside Survey (NRS). In 2013 and 2014 NHTSA conducted another roadside study to estimate the change in drug- and alcohol-positive drivers on the road before and after Washington State legalized recreational use of cannabis. Such roadside studies provide an objective measure of the extent of alcohol and other drugs in drivers' systems while they are actually on the roadway, but these studies do not include drivers involved in crashes. In 2010 and 2011 NHTSA sponsored the first large-scale and carefully controlled study in the United States designed to estimate the relative crash risk associated with drug use other than alcohol. While the study did include injury and fatal crashes, a large percentage (66.4%) of the sample consisted of drivers involved in property-damage-only crashes. Also, the study did not include information on drug prevalence among other roadway users such as pedestrians, bicyclists, and passengers involved in crashes.

While these studies have provided substantial insights into drugged driving, a knowledge gap exists regarding alcohol and other drug prevalence among drivers and other road users — pedestrians, bicyclists — who are seriously or fatally injured in crashes in the United States. The current study sought to fill the gaps in research by examining alcohol and other drug prevalence among a large sample of seriously injured drivers and other crash victims presenting to seven selected trauma centers and fatally injured crash victims presenting directly to four medical examiners (MEs). The drugs of interest were those known or suspected to impair cognitive and motor skills important for driving safely.

Methods

The study selected seven Level 1 trauma centers that served large catchment areas. Level 1 trauma centers care for people with traumatic injuries, such as from motor vehicle crashes. Participants ("seriously injured") were included in the study if the facility alerted its trauma team. MEs were able to join the study at four of these sites. Specimen collection began on a rolling basis as shown below.

- Jacksonville, FL – September 10, 2019 to July 31, 2021
- Charlotte, NC – September 16, 2019 to July 31, 2021
- Miami, FL – October 17, 2019 to July 31, 2021
- Baltimore, MD – December 11, 2019 to July 31, 2021
- Worcester, MA – January 27, 2020 to July 31, 2021

- Iowa City, IA – August 24, 2020 to July 31, 2021
- Sacramento, CA – November 13, 2020 to July 31, 2021

The sequence below demonstrates how a typical participant entered the study and resulted in a specimen included in the analyses.

1. Injured in a crash as a driver, passenger, pedestrian, bicyclist, or other roadway user
2. Transported to trauma center (or morgue if deceased at the crash scene)
3. Trauma team alerted by EMS or treating physicians
4. Blood samples gathered by clinical staff during normal treatment or autopsy procedures and other data collected (all de-identified)
5. Samples refrigerated and processed as needed before being sent to the toxicology lab

A total of 7,279 roadway users met the study's inclusion criteria and had sufficient blood volume available for full toxicological screening and confirmation testing.

Results

Overall, 55.8% of the injured or killed roadway users tested positive for one or more drugs (including alcohol) on the study's toxicology panel. As shown in Table ES-1, ME cases (participants) showed higher overall drug positivity than trauma center cases (67.7% versus 54.2%), but comparisons across sources (trauma centers versus MEs) should be made with caution due to differences in study protocols and other factors by case source.

As shown in Table ES-1, the most prevalent drug category among all road users in the study sample was cannabinoids (active THC) with 25.1% positive, followed by alcohol at 23.1%, stimulants at 10.8%, and opioids at 9.3%. Overall, 19.9% of the road users tested positive for two or more categories of drugs.[1] The ME cases tended to show higher positivity than the trauma center cases for each of the drug categories.

[1] [Editor's note: Many NHTSA reports refer to use of more than one drug as "polydrug" use. This is especially true in training manuals and other publications having to do with Drug Evaluation and Classification (DEC) systems used to train police drug recognition experts. See for example the participant manual for the DEC preliminary school at www.nhtsa.gov/sites/nhtsa.gov/files/documents/dec_preliminary_school_participant_manual-tag.pdf and the participant manual for the Advanced Roadside Impaired Driving Enforcement course at www.nhtsa.gov/sites/nhtsa.gov/files/documents/aride_participant_manual-tag.pdf]

Table ES-1. Drug Category Positivity by Case Source for All Road Users

	Trauma Center (*n* =6,382)			Medical Examiner (*n* =897)			Total (*N* =7,279)		
Drug Category	n	%	95% CI	n	%	95% CI	n	%	95% CI
Alcohol	1,364	21.4	[20.4, 22.4]	321	35.8	[32.7, 39.0]	1,685	23.1	[22.2, 24.1]
Cannabinoids^	1,579	24.7	[23.7, 25.8]	251	28.0	[25.1, 31.0]	1,830	25.1	[24.2, 26.1]
Stimulants	675	10.6	[9.8, 11.3]	112	12.5	[10.4, 14.8]	787	10.8	[10.1, 11.5]
Sedatives	475	7.4	[6.8, 8.1]	73	8.1	[6.5, 10.1]	548	7.5	[6.9, 8.2]
Opioids	541	8.5	[7.8, 9.2]	137	15.3	[13.0, 17.7]	678	9.3	[8.7, 10.0]
Antidepressants	64	1.0	[0.8, 1.3]	10	1.1	[0.6, 2.0]	74	1.0	[0.8, 1.3]
Over-the-Counter	106	1.7	[1.4, 2.0]	39	4.3	[3.2, 5.8]	145	2.0	[1.7, 2.3]
Other Drugs	97	1.5	[1.2, 1.8]	36	4.0	[2.9, 5.4]	133	1.8	[1.5, 2.2]
Positive for Any Drug	3,456	54.2	[52.9, 55.4]	607	67.7	[64.6, 70.7]	4,063	55.8	[54.7, 57.0]
Drug Negative	2,926	45.8	[44.6, 47.1]	290	32.3	[29.3, 35.4]	3,216	44.2	[43.0, 45.3]
Positive for 2 or More Drug Categories	1,163	18.2	[17.3, 19.2]	286	31.9	[28.9, 35.0]	1,449	19.9	[19.0, 20.8]

^Active THC (Δ-9-THC or 11-OH-THC).

Notes: "Drug" refers to alcohol, medications, and other drugs included on this study's toxicology panel. This table combines data from all road users (drivers, pedestrians, bicyclists, passengers, other road users) included in the study.

The study examined drug positivity by position in crash. Table ES-2 provides drug category positivity rates for drivers including motorcycle operators, pedestrians, and bicyclists presenting to the trauma centers. The Results section includes additional data for motor vehicle passengers and "other" road users (e.g., moped and electric kick scooter riders).

Table ES-2. Trauma Center Cases: Drivers, Pedestrians, and Bicyclists Positive for Drug Category

	Driver (*n* =4,243)			Pedestrian (*n* =776)			Bicyclist (*n* =232)		
Drug Category	n	%	95% CI	n	%	95% CI	n	%	95% CI
Alcohol	917	21.6	[20.4, 22.9]	192	24.7	[21.8, 27.9]	38	16.4	[12.0, 21.5]
Cannabinoids^	1,061	25.0	[23.7, 26.3]	167	21.5	[18.7, 24.5]	40	17.2	[12.8, 22.5]
Stimulants	417	9.8	[9.0, 10.8]	106	13.7	[11.4, 16.2]	26	11.2	[7.6, 15.7]
Sedatives	319	7.5	[6.8, 8.3]	66	8.5	[6.7, 10.6]	8	3.4	[1.6, 6.4]
Opioids	367	8.6	[7.8, 9.5]	56	7.2	[5.6, 9.2]	14	6.0	[3.5, 9.7]
Antidepressants	50	1.2	[0.9, 1.5]	6	0.8	[0.3, 1.6]	2	0.9	[0.2, 2.7]
Over-the-Counter	63	1.5	[1.2, 1.9]	20	2.6	[1.6, 3.9]	3	1.3	[0.4, 3.4]
Other Drugs	63	1.5	[1.2, 1.9]	16	2.1	[1.2, 3.2]	3	1.3	[0.4, 3.4]
Positive for Any Drug	2,307	54.4	[52.9, 55.9]	424	54.6	[51.1, 58.1]	100	43.1	[36.8, 49.5]
Drug Negative	1,936	45.6	[44.1, 47.1]	352	45.4	[41.9, 48.9]	132	56.9	[50.5, 63.2]
Positive for 2 or More Drug Categories	768	18.1	[17.0, 19.3]	156	20.1	[17.4, 23.0]	29	12.5	[8.7, 17.2]

^Active THC (Δ-9-THC or 11-OH-THC).

Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

As seen in Table ES-2, 54.4% of drivers including motorcycle operators, 54.6% of pedestrians, and 43.1% of bicyclists presenting to the trauma centers tested positive for one or more drugs included in the study's drug panel. Drug category positivity does appear to vary somewhat by position in crash. For drivers the most prevalent drug category was cannabinoids (active THC) at 25.0%, followed by alcohol at 21.6%, and stimulants at 9.8%. Additionally, 18.1% of the total trauma center driver cases tested positive for two or more categories of drugs. Pedestrians showed a somewhat different pattern with alcohol being the most prevalent at 24.7%, followed by cannabinoids at 21.5%, and stimulants at 13.7%. For pedestrians, 20.1% tested positive for two or more categories. Bicyclists tended to show lower drug positivity for each category, but the results should be interpreted with caution because of the relatively small number of bicyclists included in the study.

Table ES-3 provides drug category positivity rates for fatally injured drivers (including motorcyclists), pedestrians and bicyclists presenting to the MEs. Overall, 68.8% of drivers, 68.6% of pedestrians, and 56.5% of bicyclists presenting to the MEs tested positive for one or more drugs included on the study's panel. For drivers presenting to the MEs, alcohol was the most prevalent at 38.9%, followed by cannabinoids at 31.7%, and opioids at 13.0%. Additionally, 33.9% of the ME driver cases tested positive for two or more categories of drugs. Pedestrians presenting to the MEs showed a slightly different pattern with alcohol being the most prevalent at 35.7%, followed by opioids at 22.2%, and cannabinoids at 17.4%. ME pedestrian cases tested positive for two or more categories of drugs 33.8% of the time. The pedestrian and bicyclist results should be interpreted with caution because of the relatively small sample size for ME cases.

Table ES-3. ME Cases: Drivers, Pedestrians, and Bicyclists Positive for Drug Category

	Driver (*n* =555)			Pedestrian (*n* =207)			Bicyclist (*n* =23)		
Drug Category	n	%	95% CI	n	%	95% CI	n	%	95% CI
Alcohol	216	38.9	[34.9, 43.0]	74	35.7	[29.5, 42.4]	2	8.7	[1.9, 25.1]
Cannabinoids^	176	31.7	[27.9, 35.7]	36	17.4	[12.7, 23.0]	7	30.4	[14.8, 50.7]
Stimulants	70	12.6	[10.0, 15.6]	27	13.0	[9.0, 18.1]	3	13.0	[3.8, 30.9]
Sedatives	40	7.2	[5.3, 9.6]	25	12.1	[8.2, 17.0]	0	0.0	[0.0, 0.0]
Opioids	72	13.0	[10.4, 16.0]	46	22.2	[17.0, 28.2]	4	17.4	[6.2, 36.2]
Antidepressants	4	0.7	[0.3, 1.7]	4	1.9	[0.7, 4.5]	0	0.0	[0.0, 0.0]
Over-the-Counter	25	4.5	[3.0, 6.5]	11	5.3	[2.9, 9.0]	0	0.0	[0.0, 0.0]
Other Drugs	27	4.9	[3.3, 6.9]	7	3.4	[1.5, 6.5]	0	0.0	[0.0, 0.0]
Positive for Any Drug	382	68.8	[64.9, 72.6]	142	68.6	[62.1, 74.6]	13	56.5	[36.5, 75.0]
Drug Negative	173	31.2	[27.4, 35.1]	65	31.4	[25.4, 37.9]	10	45.7	[25.0, 63.5]
Positive for 2 or More Drug Categories	188	33.9	[30.0, 37.9]	70	33.8	[27.6, 40.5	3	13.0	[3.8, 30.9]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Because of the large number of drivers, the study was able to reliably analyze drug prevalence by driver demographics and other factors. Among drivers, males and females showed differences in drug category positivity with males more likely to be positive for some categories of drugs (i.e., alcohol, cannabinoids, stimulants) and females more likely to be positive for others (i.e., sedatives, antidepressants, over-the-counter [OTC] drugs). There were also a variety of differences in drug prevalence by driver age group, time of day, and day of week that are potentially useful for informing countermeasure development depending on the target audience.

Discussion

The results included in this report represent a first high-level look at drug prevalence among a large sample of seriously or fatally injured roadway users. Future research can analyze the data collected by this study to explore many more topics of interest. The study also sets an example by which future similar research can be conducted at other sites across the country. The participating Level 1 trauma centers and MEs were able to enact the study protocols without issue, even during the COVID-19 public health emergency. Future similar research at these sites or others across the country could be of use for monitoring changes in drugged driving over time and could inform traffic safety stakeholders to better tailor impaired driving countermeasures for particular regions or types of road users.

This study's results can only be used to estimate the prevalence of drug positivity among the specific populations sampled and with full awareness of the study's design limitations. The study results should not be used to imply impairment, or increased risk associated with drug presence.

Introduction

Over the last few decades interest in how drugs other than alcohol may be affecting roadway safety has increased because of several factors. First, in the United States the topic has gained prominence as an increasing number of States have legalized cannabis/marijuana[2] consumption since California first allowed the medicinal use of cannabis in 1996. As of this writing 37 States and Washington, DC, allow the sale of medicinal cannabis, and 18 States and Washington, DC, permit the regulated non-medical/recreational use of cannabis (NCSL, 2022).

Second, the "opioid epidemic" has prompted concerns that this class of drugs may be affecting drivers and other roadway users given large increases in use among the general public. The Centers for Disease Control and Prevention (CDC, 2021) identified three waves of opioid overdoses that started with prescription opioids in the 1990s, heroin beginning in 2010, and synthetic opioids such as fentanyl starting in 2013, but it is not clear how opioid use has affected roadway safety.

Third, for the period from 2015 to 2018 roughly 49% of Americans used at least one prescription drug in the 30 days prior to the survey date compared to about 38% for the period from 1988 to 1994 (National Center for Health Statistics, 2021). It is not fully understood how increases in prescription drug use may be affecting safety on America's roads.

Determining whether these and other factors have translated to more drugged driving has required an expanded research focus that includes consideration of drugs other than alcohol. Thus, NHTSA began testing for drugs other than alcohol as part of its 2007 National Roadside Survey (NRS) (Lacey et al., 2009) and continued testing in the next NRS in 2013-2014. A comparison of the 2007 and 2013-2014 NRS nighttime weekend results showed increases in overall drug use with cannabis representing the major change (Kelley-Baker et al., 2017). In 2014 and 2015 NHTSA conducted another roadside study to estimate the change in drug- and alcohol-positive drivers on the road before and after Washington State legalized recreational use of cannabis (Ramirez et al., 2016). That study showed increases in THC prevalence among drivers after legalization with the greatest increase occurring during daytime measurement periods (7.8% positive pre-legalization versus 18.9% positive one year after legalization). Such roadside studies provide an objective measure of the extent of alcohol and other drugs in drivers' systems while they are on the roadway, but these studies do not include drivers involved in crashes.

In 2010 and 2011 NHTSA sponsored the first large-scale and carefully controlled study in the United States designed to estimate the relative crash risk associated with drug use other than alcohol (Compton & Berning, 2015; Lacey et al., 2016). Known as the "Virginia Beach study" -- its sampling location -- it used a case-control design and included drivers involved in police-reported crashes. While the study did include injury and fatal crashes, a large percentage (66.4%) of the sample consisted of drivers involved in property-damage-only crashes. Consistent with prior studies such as Blomberg et al. (2009), alcohol -positive drivers had increased odds of being involved in crashes, and risk was elevated at higher blood alcohol concentrations (BAC).

[2] The terms "cannabis" and "marijuana" are often used interchangeably but are not fully synonymous. Cannabis refers to the *Cannabis sativa/indica/ruderalis* plants and broadly covers all products derived from them. Marijuana is a non-scientific term usually referring to the parts of the plants that contain the psychoactive compound tetrahydrocannabinol (THC). This report uses the terms cannabis and cannabinoids to refer to the potentially impairing chemical compounds of interest, including what might (less precisely) be referred to as marijuana.

THC initially appeared to be associated with higher odds of being involved in a crash, but after driver age and sex were taken into consideration no increase in risk could be associated with the presence of THC in a driver's system. The study did not include information on drug prevalence among other roadway users (pedestrians, bicyclists, passengers) involved in crashes.

Only one study has attempted to estimate the risk associated with alcohol and other drug use by drivers involved in serious injury or fatal crashes (Hels et al., 2011). This large-scale European study found that drugs other than alcohol could potentially increase the risk of being seriously injured in a crash, but the study did not test for as many drugs as the Virginia Beach study and had some methodological issues inherent in this type and scale of research being conducted at several sites. A study conducted in Canada examined the prevalence of alcohol and a variety of other potentially impairing drugs among injured drivers who arrived for treatment at an emergency department within 6 hours of a crash during 2018 to 2021 (Brubacher et al., 2021). De-identified study samples (N = 4,976) were obtained under a waiver of consent when a physician had already ordered blood for clinical/treatment purposes. Overall, 50.8% of the drivers tested positive for at least one drug included on the study's toxicology panel. Alcohol (15.5%) and cannabis (active THC, 18.8%) were the most prevalent individual drugs while 10.9% tested positive for other recreational drugs (e.g., cocaine, amphetamines), and 20.7% tested positive for some type of sedating medication as classified by the study. The study did not include any roadway users other than drivers.

The above studies provided substantial insights into drugged driving, but a knowledge gap exists regarding drug use among drivers and other road users (e.g., pedestrians, bicyclists) who are seriously or fatally injured in crashes in the United States. Part of this gap is due to inconsistencies in how drug data are collected by States and reported to NHTSA for entry into its Fatality Analysis Reporting System (FARS). As noted by Berning and Smither (2014) and Berning et al. (2022), State drug testing and reporting policies and procedures vary widely for individuals involved in fatal crashes substantially limiting FARS' usefulness for understanding the role drugs could be playing in fatal crashes. The current study sought to fill these gaps by examining drug prevalence among a large sample of seriously injured drivers and other crash victims presenting to selected trauma centers, and fatally injured crash victims presenting directly to medical examiners (MEs) at selected sites.[3]

Shortly after this project began, however, an outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections started a pandemic of respiratory disease (commonly referred to as COVID-19). A public health emergency was declared on March 13, 2020 (White House, 2020). Notable changes in travel patterns and driver behaviors were documented in special reports released by NHTSA (Wagner et al., 2020; Office of Behavioral Safety Research, 2021a, 2021b). These reports indicated Americans were driving less early in the public health emergency. However, those who remained on the roads engaged in riskier behaviors, including speeding and failure to wear seat belts, which may have contributed to the substantial increases in observed fatality rates (Office of Behavioral Safety Research, 2021a). This study's protocols were revised to meet new restrictions on research at the selected trauma centers and to process samples to allow the National Institutes of Health (NIH) to conduct serological testing of collected samples for COVID-19 antibodies as part of a separate, but coordinated, research effort

[3] A person pronounced dead at the scene of a crash is often taken directly to the ME or coroner's office, but not always. Some of the trauma center cases included this study may have died at the scene but were still transported to the hospital, died during transport, or succumbed to their injuries at a later date.

(Ngo et al., 2021). The study continued data collection and added two trauma center sites during the public health emergency.

An interim report on this study (Thomas et al., 2020) provided preliminary results for five of the research sites before the public health emergency began and during the early months of the public health emergency at those five sites. The preliminary findings suggested overall drug prevalence among the seriously or fatally injured road users at the study sites was higher after the public health emergency was declared. The most notable increases were for cannabinoids, opioids, and alcohol. While these increases could be due to factors such as normal seasonal fluctuations, the observed increases in drug prevalence were consistent with other concurrent research that indicated people were drinking more alcohol and increasing their use of other drugs during the early stages of the pandemic (e.g., Grossman et al., 2020; Czeisler et al., 2020). The study continued to provide updates on drug prevalence changes over time at the five original study sites as part of the NHTSA COVID-19 traffic safety update reports mentioned above.

This final report provides an examination of overall drug prevalence across the entire study period and all seven study sites combined. The results provide a first look at drug prevalence within a large sample of seriously or fatally injured roadway users in the United States. Limitations of the data collection are discussed throughout with specific cautions regarding the interpretation of any results.

Objective

The objective of this study was to examine the prevalence of alcohol, OTC, prescription, and illegal drugs in the blood of a large sample of seriously or fatally injured drivers and other road user crash victims in the United States.

Methods

Study Sites

Researchers conducted a nationwide site selection process that included a review of publicly available information on the following.

- Locations of Level 1 trauma centers (those centers that treat the most serious injuries and routinely collect blood for research purposes)
- Size of the surrounding population served by each trauma center
- Number of other trauma centers serving the same population
- Prior history of traffic safety research at the potential sites

When a site appeared promising, trauma center management was contacted and more information was gathered on the following.

- Degree of trauma center interest in the study
- Annual driver/patient flow rate
- Nature of catchment area (e.g., urban, suburban, rural)
- Experience of staff in conducting research projects
- Extent of routine blood collection
- Degree of local ME interest
- Estimated cost for participation in the study

The study team selected seven Level 1 trauma centers that served large catchment areas. This approach ensured the study would capture the majority of seriously or fatally injured roadway users in each area and could acquire a large sample size in a relatively short period of time. The seven selected sites are described below, listed in the order in which data collection began at the site.

Jacksonville, Florida. The University of Florida Health TraumaOne (UF Health) serves as the only Level 1 trauma center in northeast Florida and southeast Georgia. The Duval County ME's office joined on the project for cases involving deceased roadway users in the county.

Charlotte, North Carolina. Atrium Health/Carolinas Medical Center is the only Level 1 trauma center in the Charlotte area and serves patients from both North Carolina and South Carolina. The study also joined with the Mecklenburg County ME's office on cases involving deceased roadway users in the county.

Miami, Florida. The Ryder Trauma Center at the University of Miami/Jackson Memorial Medical Center served as the as the Level 1 trauma center sampling site in South Florida. The study joined with the Miami-Dade ME's office on cases involving deceased roadway users in the county.

Baltimore, Maryland. The R. Adams Cowley Shock Trauma Center at the University of Maryland Medical Center is a primary adult resource center that includes a Level 1 trauma center. The study also joined with the Maryland Office of the Chief Medical Examiner on cases involving the deceased roadway users for the entire State of Maryland. Johns Hopkins University assisted with ME data collection.

Worcester, Massachusetts. UMass Memorial Health Care operates a Level 1 trauma center in Worcester. The University of Massachusetts, Amherst, assisted the project in the acquisition of study data. Specimens from local ME cases were not available for independent analysis by this study.

Iowa City, Iowa. The University of Iowa Health Care operates a Level 1 trauma center in Iowa City. The University of Iowa assisted the project with the acquisition of study data. Specimens from local ME cases were not available for independent analysis by this study.

Sacramento, California. University of California Davis Medical Center in Sacramento functions as California's only Level 1 trauma center north of San Francisco. Specimens from local ME cases were not available for independent analysis by this study.

Office of Management and Budget and Institutional Review Board Approvals

This study received approval from the Office of Management and Budget (OMB Control Number 2127- 0744), the Advarra Institutional Review Board (which served as the central IRB for six sites), and the University of Florida Institutional Review Board (for UF Health Jacksonville). De-identified specimens and other data were included in the study under IRB-approved waivers of consent and authorization. No compensation was provided to participants.

Dates of Collection

Specimen collection began on a rolling basis across sites. The start and end dates of collection at each site covered by this report are as follows.

- Jacksonville – September 10, 2019, to July 31, 2021
- Charlotte – September 16, 2019, to July 31, 2021
- Miami – October 17, 2019, to July 31, 2021
- Baltimore – December 11, 2019, to July 31, 2021
- Worcester – January 27, 2020, to July 31, 2021
- Iowa City – August 24, 2020, to July 31, 2021
- Sacramento – November 13, 2020, to July 31, 2021

Participants

Participants each included a sample[4] of seriously or fatally injured roadway users who were involved in motor vehicle crashes (MVCs) in the catchment areas of the participating Level 1 trauma centers and MEs. Each of the injured participants was transported from the scene of the crash to the participating trauma centers, and those who had died at the scene of a crash were transported directly to the ME offices. The following types of roadway users were included as the facility alerted its trauma team.

- Drivers of motor vehicles (e.g., cars, pickup trucks, SUVs, motorcycles)
- Passengers in motor vehicles

[4] The study attempted to collect specimens "24/7" at each site with the goal of collecting a specimen from every seriously or fatally injured roadway user who met the study's inclusion criteria. It is unknown how many eligible cases were missed at a given site. Pandemic-related issues associated with research staffing at the study hospitals and policies related to access to patient care areas could have affected specimen and other data acquisition efforts at each site differently.

- Bicyclists
- Pedestrians
- Other people injured in MVCs while on the roadways (e.g., moped riders, all-terrain vehicle [ATV] riders, and electric kick scooter riders)

The study team sought to obtain blood specimens and related study information on every potential participant who met the following inclusion criteria.

- Roadway user sustaining injuries in an MVC that were serious enough to require trauma team alert/activation at one of the participating trauma centers or a person declared deceased at the scene of a crash and transported directly to the ME's office.
- Blood collection necessitated as part of clinical treatment or for autopsy purposes.
- Age 18 or older.

For trauma center cases the study team aimed to collect each specimen within 6 hours of the crash event, but exact crash times were unavailable for some cases (e.g., pedestrians "found down" after a hit-and-run crash). Cases without recorded crash times were included when it was determined the crash had likely occurred within 6 hours of arrival at the trauma center where blood was collected. The study allowed for transfers from other hospitals if it could be verified the individual arrived at the study's Level 1 trauma center within 6 hours of the crash. Drugs administered by all EMS providers and the transferring hospital's treating staff were accounted for in data collection. ME cases generally had blood drawn more than 6 hours after the crash in keeping with standard specimen collection practices for autopsies at each site.[5]

The trauma centers and MEs provided specimens from a total of 7,572 suspected MVC victims. Of these, study staff were able to confirm 7,279 were roadway users who met the criteria and had sufficient blood volume available for full toxicological screening and confirmation testing. 0 shows the number of participants varied substantially across sites because of the rolling start dates, patient flow rate differences, and unavailability of specimens for ME cases at some sites. 0 shows that 67.5% of the total sample was male, with 76.1% of ME cases being male versus 66.3% of trauma center cases. 0 provides counts and percentages of participants in selected age categories with the great majority of participants falling between the ages of 21 to 64 for both trauma center and ME cases.

Table 1. Trauma Center and Medical Examiner Case Counts by Site

	Jacksonville	Charlotte	Miami	Baltimore	Worcester	Iowa City	Sacramento	Total
Trauma	972	1,710	1,296	1,157	408	350	489	6,382
ME	39	103	92	663	0	0	0	897
Total	1,011	1,813	1,388	1,820	408	350	489	7,279

[5] After death, a variety of factors affect metabolism of some drugs and redistribution in the body that can influence drug detection and drug concentrations observed in specimens. As such, caution should be made when comparing ME case results to trauma center results, especially where drug concentrations are concerned.

Table 2. Sex by Case Source

	Trauma Center		Medical Examiner		Total	
	n	%	*n*	%	*N*	%
Male	4,229	66.3	683	76.1	4,912	67.5
Female	2,136	33.5	208	23.2	2,344	32.2
Unknown	17	0.3	6	0.7	23	0.3

Table 3. Age by Case Source

	Trauma Center		Medical Examiner		Total	
	n	%	*n*	%	*N*	%
18-20	414	6.5	45	5.0	459	6.3
21-34	2,300	36.0	291	32.4	2,591	35.6
35-44	1,113	17.4	160	17.8	1,273	17.5
45-64	1,758	27.5	270	30.1	2,028	27.9
65+	789	12.4	110	12.3	899	12.4
Unknown	8	0.1	21	2.3	29	0.4

Table 4 provides counts and percentages of participants by their positions in crashes with 65.9% of the total sample being drivers. Motorcycle operators are included in the driver category in the tables that follow. Appendix A tables break out drivers by vehicle type. The "Other" category includes road users such as moped, ATV, and electric kick scooter riders on the roadway who were involved in motor vehicle crashes. Participants were classified as "Unknown" position if it was not clear where they were located during crashes. This was most common in crashes with several vehicle ejections.

Table 4. Position in Crash by Case Source

	Trauma Center		Medical Examiner		Total	
	n	%	*n*	%	*N*	%
Driver	4,243	66.5	555	61.9	4,798	65.9
Passenger	936	14.7	95	10.6	1,031	14.2
Bicycle rider	232	3.6	23	2.6	255	3.5
Pedestrian	776	12.2	207	23.1	983	13.5
Other	126	2.0	3	0.3	129	1.8
Unknown	69	1.1	14	1.6	83	1.1

Note: Motorcycle operators/riders are included in the Driver category.

The median (Mdn) and mean/average (M) times from crash to blood draw are shown separately for trauma center and ME cases in Table 5. For trauma center cases, the times are broken out by whether the person came directly from the scene of the crash to this study's trauma centers or first went to another hospital before being transferred to a study center. "Other" transport origins include cases when a person left the crash scene (e.g., taken to police station for arrest, walked/drove to nearby location) but was shortly thereafter transported to a trauma center. Unknown transport origin cases had known crash times and met all study inclusion criteria but based on available information it could not be determined if these individuals came directly from the crash scene or went to another location first.

Table 5. Time (Minutes) from Crash to Blood Draw

	Trauma Center				Medical Examiner			
Transport Origin	*n*	*Mdn*	*M (SD)*		*n*	*Mdn*	*M (SD)*	
Direct from Scene	5,292	45.0	50.8	(31.5)	858	1,263.5	1,544.7	(1,213.8)
Transfer	512	199.5	192.0	(94.3)	n/a	n/a	n/a	n/a
Other/Unknown	99	68.0	96.8	(79.8)	n/a	n/a	n/a	n/a
Total	5,903	47.0	63.8	(58.0)	858	1,263.5	1,544.7	(1,213.8)

Note: Counts exclude cases with insufficient time information to calculate a time from crash to blood draw. A total of 479 trauma center cases and 39 ME cases did not have time from crash to blood draw calculated.

A total of 479 trauma center cases that were included in the final analyses did not have enough data available to determine the time from crash to blood draw, but a review of other study information indicated there was a high likelihood the blood draw took place well within the 6- hour window from the crash. Similarly, ME cases included in the final analyses did not have sufficient time data available for calculation of time from crash to blood draw for 39 cases.

Materials

Blood Collection Tubes

Each tube was labeled with a unique study identification number and a corresponding barcode. Before the public health emergency began, blood samples at the trauma centers and MEs were collected in 6 mL gray-top BD Vacutainer tubes containing sodium fluoride (stabilizer) and potassium oxalate (anti-coagulant) to ensure drug stability in the uncoagulated blood. To ensure viable plasma could be obtained for COVID-19 antibody testing for trauma center cases for NIH's analytical purposes, the study protocol shifted to collecting samples at the trauma centers in 10 mL lavender-top BD Vacutainer tubes containing EDTA (anti-coagulant) during the public health emergency.[6] Samples were then split with up to 6 mL of blood placed in a gray-top tube for toxicological analyses and the remainder processed for plasma for antibody testing by NIH. MEs continued to collect samples in the 6 mL gray-top tubes during the public health emergency.

Shipping Materials

All study shipping materials complied with the U.S. Department of Transportation and International Air Transport Association's (IATA) requirements for shipping biological substances, Category B (UN3373). Samples were first placed in containers designed for the transport of blood tubes. Absorbent material was placed around the samples in case of spillage. Containers that were not already 95kPa-rated were placed in a leak-proof 95kPa bag and sealed to prevent issues associated with pressure changes encountered during air transport at high altitudes. The container was placed in an insulated cooler and surrounded by gel refrigerant packs to maintain samples at a refrigerated temperature throughout shipping. The cooler was placed inside a box with DOT/IATA-compliant markings (Figure 1).

[6] Gray-top tubes are generally not used when plasma is required for serological testing because the additives in the tube may interfere with test results. Using lavender-top tubes for initial sample collection allowed for the conduct of both the toxicology and serological testing with minimal impact on either set of results.

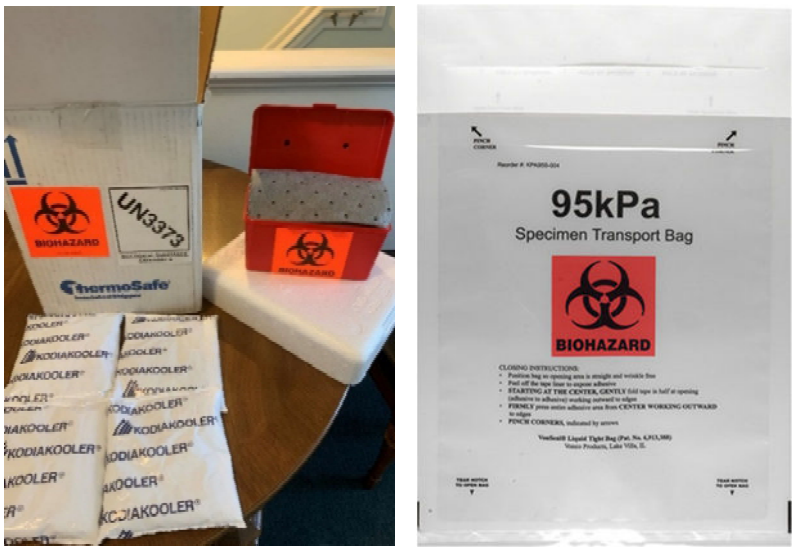

Figure 1. Packing Materials and 95kPA Bag Example

Data Collection System

The study used the Voxco software platform for a custom data collection system. The data collection system allowed research assistants to input data in an offline or online mode on a study tablet or enter data into a web-based portal from any computer with a compatible browser. Data collected in offline mode was securely transmitted to the central database as soon as an Internet connection was established. The study used Samsung Galaxy Tab A 10.1 tablets with the Android operating system. Tablets were housed in antimicrobial cases (Figure 2).

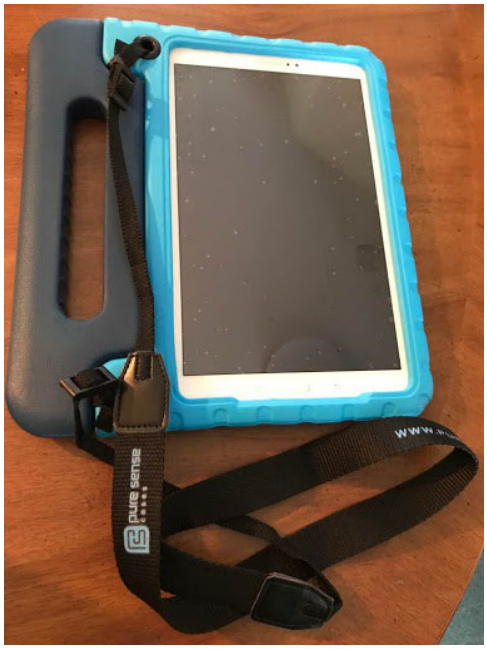

Figure 2. Data Collection Tablets

The data security approach was compliant with Federal regulations. The central database system used highly secure internal network storage to prevent data loss, corruption, and unauthorized breach, as well as to administer least privilege, password protected access rights, thus safeguarding all data. The study employed data encryption for both storage and transfer, redundant and fault tolerant disk arrays, strong challenge-response user ID/password combinations, a restrictive role-based access scheme, virus protection, audit trails, third-party audit reviews, secure data networks, uninterrupted power supply, regular back-ups with offsite storage, a recovery plan in the event of a disaster, limited and monitored physical site entry, and comprehensive employee training programs. The study also had systems in place to detect and respond to any unauthorized intrusions.

Data Collection Cards

When collecting data in the patient treatment area, staff had the option to use paper data collection cards (Figure 3) for initial data capture notes. Information was then entered into the tablets or online portal as time permitted. These cards were stored in a secure location at each hospital until data could be entered into the tablet or online portal. The cards were then destroyed per hospital protocols once all data were entered and verified to be correct.

Study ID: _____ **Arrival Date:** _____ **Arrival Time**: _____ **Trauma Act:**_____

Mechanism of Injury: MVC Other: _____

Position in Crash: Driver Passenger Bicycle Pedestrian Scooter Unknown Other: _____

Motor Vehicle Type: Car SUV Pickup Truck Van Motorcycle Semi-Truck Other: _____

Airbag: Yes/No/Unknown **Seatbelt:** Yes/No/Unknown **Helmet:** Yes/No/Unknown

Transport Mode: Ground Air Police Vehicle Unknown Other: _____

Transport Origin: Scene of injury Transfer from other facility Other: _____

EMS Agency: _____ **LE Agency:** _____

EMS Drugs Prior to Arrival: None Ativan Fentanyl Haldol Ketamine Morphine Versed

ER Drugs Prior to Draw: None Ativan Dilaudid Etomidate Fentanyl Haldol Ketamine Morphine Versed

Study Blood Tube ID: _____

Crash Location (Intersection, City/County, Landmarks, Coordinates, Mile Marker):

Reported Symptoms: _____

Temperature reading: _____

Criteria for Testing: Symptoms Exposure to case Healthcare worker Unknown Other:_____

Figure 3. Data Collection Card

Crash Information

When hospital research staff were allowed to be in patient care areas, they were able to listen to EMS reports being provided to the treating staff and record details of the crash on the data collection cards. This information was supplemented by reviews of EMS run sheets and hospital records that contained details on the crash. The study also reviewed crash reports when available to verify crash details. When access to patient care areas was restricted during the public health emergency, the study relied more heavily on EMS run sheets, hospital records, and crash reports to gather crash details. No personal identifiers were ever entered into the study database.

Selected Drugs

NHTSA research traditionally focuses on testing for those drugs that are known, or suspected, to impair cognitive and motor skills important for driving safety. These include alcohol as well as OTC, prescription, and illegal drugs. The results of the prior NRSs, the Washington roadside survey, and Virginia Beach study formed the foundation for the drugs selected for analysis in the present study. Table 6 contains the list of the parent drugs and metabolites included in this study's toxicological testing.

Table 6. Selected Drugs and Metabolites for Toxicology Testing

Class/Category	Parent Drug or *Metabolite* (Abbreviation)
Alcohol	ethyl alcohol
Cannabinoids	delta-9-tetrahydrocannabinol (Δ-9-THC), *11-hydroxy-Δ□-tetrahydrocannabinol (11-OH-THC), 11-nor-9-carboxy-Δ□-tetrahydrocannabinol (11-COOH-THC)*[#]
Stimulants	cocaine, *benzoylecgonine (BZE)*[#]*, cocaethylene*; amphetamine; methamphetamine; 3,4-methylenedioxy-methamphetamine (MDMA); 3,4-methylenedioxyamphetamine (MDA); ephedrine; pseudoephedrine; phenylpropanolamine; phentermine; methylphenidate
Sedatives Benzodiazepines Barbiturates Muscle Relaxers Sleep Aids	diazepam; nordiazepam*; oxazepam*; temazepam*; clonazepam, *7-aminoclonazepam*; alprazolam; lorazepam; chlordiazepoxide; midazolam; bromazepam; butalbital; secobarbital; phenobarbital; carisoprodol; meprobamate; cyclobenzaprine; zolpidem
Opioids	*6-monoacetylmorphine (6-AM)*^; morphine*; codeine; hydrocodone; hydromorphone*; oxycodone; oxymorphone*; methadone, *2-ethylidene-1, 5-dimethyl-3, 3-diphenylpyrrolidine (EDDP)*[#]; buprenorphine *norbuprenorphine*; fentanyl, *norfentanyl*[#]; furanylfentanyl; acetylfentanyl; carfentanil; fluorofentanyl; tramadol
Antidepressants	sertraline; fluoxetine; amitriptyline; nortriptyline; imipramine; desipramine; citalopram; doxepin; venlafaxine; trazadone
Over the Counter	dextromethorphan; diphenhydramine; chlorpheniramine; doxylamine
Other	phencyclidine; ketamine; α-pyrrolidinopentiophenone (alpha-PVP)

[#] Inactive metabolite.
*These compounds can be parent drugs or active metabolites of other drugs.
^Heroin can only be definitively detected by the presence of the 6-AM metabolite.

A parent drug is the original compound that is ingested, insufflated, or injected, and metabolites are products of the biological breakdown of the parent drug to excrete it from the body. Some metabolites remain active and can potentially have deleterious effects on driving performance until further metabolism is complete. Other metabolites are inactive (i.e., do not affect cognitive or motor functions) but serve as an indicator of recent drug consumption. The time it takes the body to metabolize a substance varies by drug and by the condition of the individual. The presence of an inactive metabolite in the blood indicates the parent drug was used at some time in the past, but for many drugs it is not possible to calculate with any certainty when that exposure occurred.

Unless otherwise stated, the results presented in this report include only parent drugs and active metabolites. The presence of these compounds can be confidently considered an indication that an active form of the drug was detectable in the tested individual at the time of their involvement in the crash or was administered therapeutically after the crash. If a drug positive result could be attributed to therapeutic administration (e.g., there was a record that fentanyl was given by EMS during transport), it was coded as negative in the study analysis despite the possibility the drug was already present (e.g., patient had used fentanyl recreationally) when the crash occurred.

Each individual drug has a generic name and, sometimes, one or more brand/trade names. For studies such as this one, drugs and metabolites can be classified/categorized in a variety of ways. The results reported here use the general drug classes and categories described below.

Alcohol. Alcohol (ethyl alcohol) has well-established impairing effects on psychomotor skills. Alcohol is a central nervous system depressant and affects cognitive and motor functions.

Cannabinoids. Tetrahydrocannabinol (THC) is a natural cannabinoid and the major psychoactive component of cannabis. THC can have a stimulant or sedative effect depending on the individual, and at high doses it may have a hallucinogenic type effect in rare cases. The parent drug delta-9-tetrahydrocannabinol (Δ-9-THC or delta-9-THC) and the active metabolite 11-hydroxy-Δ9-tetrahydrocannabinol (11-OH-THC or hydroxy-THC) are potentially impairing. 11-nor-9-carboxy-Δ9-tetrahydrocannabinol (11-COOH-THC or carboxy-THC) is a downstream metabolic product and does not have known impairing effects. The 11-COOH-THC metabolite could be an indicator of recent use; for heavy users the compound can remain in a person's system for several days or even weeks.

Opioids. Opioids are generally used to treat acute pain. This class of drugs can have negative effects on psychomotor function due to sedation, respiratory depression, fatigue, lightheadedness, and pupillary constriction. Continued use of opioids may allow the body to adapt to the effects via tolerance and a user may experience withdrawal when the ingestion of the drug stops. The initial use period and times of withdrawal have the highest risk for impairment.

Sedatives. Sedatives depress the central nervous system. Several types of drugs including benzodiazepines, barbiturates, muscle relaxants, and sleep aids can be classified as sedatives. Benzodiazepines are prescribed to treat anxiety, seizure disorders, and sleep-related disorders and can cause cognitive and motor function impairments. In addition, benzodiazepines may produce side effects such as weakness, clumsiness, loss of balance, dizziness, and distorted vision. Barbiturates are used to manage anxiety, seizures, migraines, and insomnia. Barbiturates can cause sedation and reduced coordination, but these drugs have largely been replaced therapeutically by benzodiazepines. Muscle relaxants are used to treat muscle spasms or muscle spasticity caused by nervous system disease. These drugs may cause drowsiness, ataxia (poor

muscle control), or blurred vision. Hypnotics are generally prescribed as sleep aids for people who suffer from insomnia. These drugs may cause dizziness or mild to extreme drowsiness.

Antidepressants. Selective serotonin reuptake inhibitors (SSRIs), serotonin and norepinephrine reuptake inhibitors (SNRIs), tricyclic, monoamine oxidase inhibitors (MAOIs), and noradrenaline and specific serotoninergic antidepressants (NASSAs) are commonly prescribed to treat depression, anxiety, personality disorders, and a wide variety of other conditions. During the first weeks of use, these drugs can cause dizziness and other side effects. Side effects such as headaches and decreased concentration may be experienced when stopping use.

Stimulants. Stimulants act on the central nervous system and generally increase alertness for short periods of time. Side effects of stimulants include dizziness, sleep problems, headaches, distorted risk perception, and irritability.

Over-the-Counter Drugs. A wide variety of drugs are available via legitimate retails sources without a prescription but can be impairing. Over-the-counter drugs of interest for this study included antihistamines, which work to stop allergy symptoms, and cough suppressants that aim to suppress the cough reflex. These drugs can have sedating effects, although tolerance can develop after use for several days.

Other Drugs. Other drugs of interest included phencyclidine (PCP), which was originally created to serve as an anesthetic but its severe side effects led to it being disallowed for human use. Ketamine is a drug generally used for anesthesia but can be used for other purposes. When used recreationally, however, both drugs may cause hallucinations, dizziness, diminished reflexes, and nystagmus (rapid involuntary movements of the eyes). A new drug, α-pyrrolidinopentiophenone (commonly known as "flakka") is said to cause unusual behavior, agitation, paranoia, and delusions of superhuman strength.

Drug Toxicology Testing

All drug toxicology analyses were conducted by the Immunalysis Corporation (Pomona, CA) research laboratory. Samples were first screened for the presence of the drugs of interest using enzyme-linked immunosorbent assays (ELISA). Alcohol screening was conducted using a similar enzyme-based screen. As the term implies, screening is a relatively quick and inexpensive, first-line chemical test to determine whether a given drug or group of drugs is likely present in the sample. The cutoff threshold (the minimum drug level at which the screen will return a positive result) for each screen was set to optimize the tradeoff between assured detection and minimizing the number of false positives.[7] Those specimens screened as "positive" then underwent a second stage of testing. This confirmation testing used liquid chromatography-tandem mass spectral detection (LC-MS/MS) for all drugs except alcohol that was confirmed by headspace gas chromatography with flame ionization detection (HS-GC-FID). Confirmation testing provided a quantitative drug concentration measurement for the individual drugs and metabolites of interest. The detection and confirmation thresholds set for various drug tests are presented in Appendix B. Figure 4 provides an example of the screening and confirmation process with results for three different hypothetical samples.

[7] A false positive occurs when a test incorrectly indicates a drug is present when it is not.

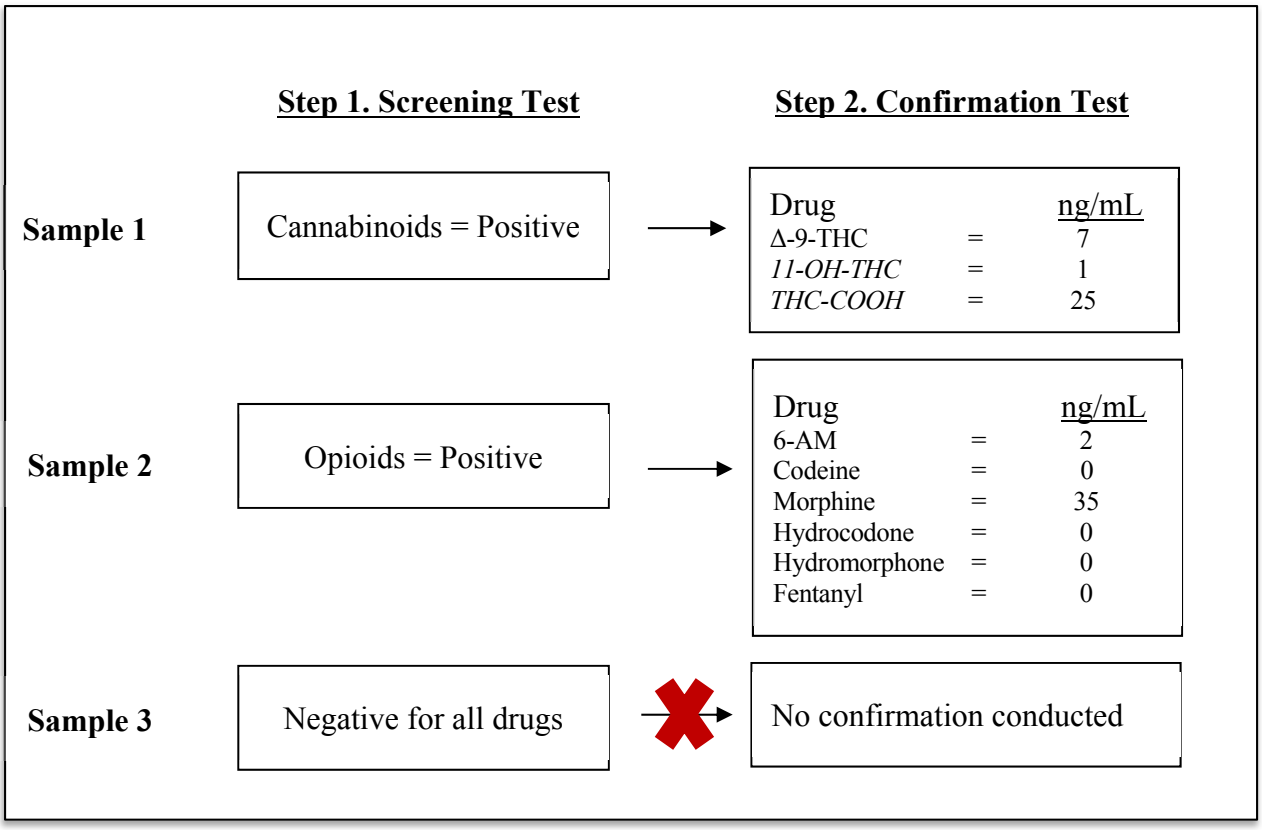

Figure 4. Examples of Drug Screening and Confirmation

Procedure

The sequence below demonstrates how a typical participant entered the study and resulted in a specimen included in the analyses.

1. Injured in a crash as a driver, passenger, pedestrian, bicyclist, or other roadway user
2. Transported to trauma center (or morgue if deceased at the crash scene)
3. Trauma team alerted by EMS or treating physicians
4. Blood samples gathered by clinical staff during normal treatment or autopsy procedures and other data collected (all de-identified)
5. Samples refrigerated and processed as needed before being sent to the toxicology lab

Blood Sample Collection

As part of their routine treatment procedures, the participating trauma centers collected blood for clinical purposes from virtually all patients for whom the trauma team was alerted. The MEs also

collected blood as part of their standard autopsy procedures. The trauma centers and MEs made available to this study small volumes of blood from the total collected during their normal activities. Trauma center specimens were collected as soon as possible upon arrival for treatment. Patient transfers from other medical facilities were accepted for inclusion in the study if the crash occurred within 6 hours of arrival at the study sampling sites, and information on drugs administered therapeutically was readily available from the first treating hospital and transporters. Samples from ME cases were collected at the time of the autopsy, which could be hours or days after death. Collection of samples from trauma victims and ME cases conformed with Federal, State, and local policies regarding collection of fluid samples for research purposes. Samples were refrigerated at 2- to 4 °C until shipped.

Shipping

Samples were packaged according to DOT/IATA standards for biological substances. Before the public health emergency, overnight shipments were made twice per week directly from each site to the toxicology laboratory. During the public health emergency, the five East Coast sites made daily overnight shipments to the central processing laboratory (Kiyatec, Greenville, South Carolina) to prepare samples for dual toxicology and antibody testing purposes. Samples collected over the weekend sometimes had to be stored for an extra one to two days because no shipping company would deliver on Sundays and some holidays. The central processing laboratory then shipped samples twice weekly to the toxicology laboratory. The Sacramento and Iowa City sites that were added later in the study conducted on-site sample processing before shipping to the toxicology lab to avoid shipping samples back-and-forth across the country.

Sample Processing During the Public Health Emergency

When the public health emergency was declared in March 2020, data collection was paused to determine appropriate protocol revisions. NHTSA and NIH collaborated to share the blood samples for COVID-19 antibody testing (in addition to the toxicology testing). As such, the study was deemed "critical research" and allowed to restart at the study sites. The study IRBs approved the request to use the samples for both purposes. To provide viable plasma for the antibody testing and protect the integrity of the toxicological analyses, blood from the lavender-top tubes needed to be processed as quickly as possible after collection. Upon receipt of the daily shipments from the five East Coast sites, Kiyatec immediately transferred blood from the lavender-top tubes to gray-top tubes, which were labeled with matching study identification numbers. The gray tops were then refrigerated until they were shipped to the toxicology laboratory. When sufficient additional blood was available, the lab processed it to extract plasma, which was then stored per NIH requirements. The Sacramento and Iowa City sites that were added during the public health emergency used the same procedures to process samples on site before shipping to the toxicology lab.

Participant and Crash Information Data Entry

Authorized study staff at each site logged into the data entry portal and manually entered the de-identified information from the data collection cards, hospital records, and crash reports as the information matured in the various systems. No personal identifiers ever entered the central study database.

Toxicology Testing

The toxicology laboratory processed samples in batches as they were received from sites or the central processing laboratory. Samples that screened positive for any of the drug classes were subjected to confirmation testing. The results were recorded by blood tube ID and sent to the central database where the information was merged with the de-identified patient and crash information. No drug toxicology results were ever returned to the trauma centers or MEs, nor was participation in the study ever recorded in the trauma center or ME records.

Data Analysis Approach

The primary objective of this study was to provide a first look at drug prevalence rates among a large sample of seriously or fatally injured roadway users at selected trauma centers and MEs. The tables that follow present raw drug category prevalence rates for trauma center and ME cases separately using the drug positivity data from all sites combined across the entire study period. Additional tables in Appendix A provide drug prevalence data by individual site. The tables focus on prevalence of a given class or category of drugs as defined by this study. A person testing positive for two individual drugs that fall in the same category is only counted a single time in the drug category positivity results. A person who tested positive for more than one category of drugs is included in the counts for each separate category of drugs for which that person tested positive. Additional tables in Appendix A provide prevalence rates for individual parent drugs and metabolites.

The body of this report focuses on drug prevalence among drivers. The tables include 95% confidence intervals for each observed prevalence rate. Chi-square tests of independence and z-tests of proportions were the primary statistical analyses applied to examine associations of variables (e.g., age, sex) with the binary drug positive/negative measure for each class of drugs. The results of the statistical analyses represent observed associations within this sample from the populations of seriously or fatally injured roadway users at the study sites. No inferences should be made regarding drug prevalence rates in any other locations or for the larger populations of seriously or fatally injured roadway users across the country given the limitations of the study design.

Inactive metabolites (e.g., 11-COOH-THC, BZE, norfentanyl, EDDP), even though included in the confirmation testing, were specifically excluded from the drug-positive counts presented below unless otherwise noted. For example, cannabinoids exposure was only identified through the presence of active THC. Given the delay from time of crash to blood draw that is inherent in a study of this type, and the greatly varying times that metabolites can remain in the blood (the inactive metabolites of THC can be detected for days or even weeks after use), it is not possible to conclude from the presence of an inactive metabolite when the corresponding drug was active. The presence of an inactive metabolite indicates with assurance that the person used the drug at some time in the past. It does not, however, provide evidence the active drug was in the person's blood at the time of the crash. Therefore, the prevalence results in the body of this report focus on confirmed positives for active parent drugs or active metabolites.

The study results account for drugs administered therapeutically by EMS and the trauma centers, or other treating hospitals (if a patient was transferred to the trauma centers), between the time of the crash and the time the blood specimen was drawn. A positive drug result that could possibly be attributed to therapeutic administration (e.g., there was a record that fentanyl was given by

EMS during transport) was considered to be negative because there was no way to determine if the drug was already present (e.g., patient had used fentanyl recreationally) when the crash occurred. Excluding inactive metabolites and drugs administered as part of medical treatment results in a conservative estimate of whether the potentially impairing components of a drug were present in a road user's system at the time a crash occurred.

Results

Overall Drug Prevalence

Table 7 provides the overall drug category positive counts and positivity rates (percentages) for the trauma center and ME cases combined across all sites (N = 7,279) and broken out by case source for descriptive comparison purposes. Overall, 55.8% of the injured or killed roadway users tested positive for one or more drugs included in this study's toxicology panel. Cannabinoids (active THC) was the most prevalent drug category at 25.1% followed by alcohol at 23.1%, stimulants at 10.8%, and opioids at 9.3%. Of the entire sample of seriously or fatally injured road users, 19.9% tested positive for two or more categories of drugs.

Table 7. Overall Drug Prevalence by Case Source

	Trauma Center (*n* =6,382)			**Medical Examiner (*n* =897)**			**Total (N =7,279)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	N	%	95% CI
Alcohol	1,364	21.4	[20.4, 22.4]	321	35.8	[32.7, 39.0]	1,685	23.1	[22.2, 24.1]
Cannabinoids^	1,579	24.7	[23.7, 25.8]	251	28.0	[25.1, 31.0]	1,830	25.1	[24.2, 26.1]
Stimulants	675	10.6	[9.8, 11.3]	112	12.5	[10.4, 14.8]	787	10.8	[10.1, 11.5]
Sedatives	475	7.4	[6.8, 8.1]	73	8.1	[6.5, 10.1]	548	7.5	[6.9, 8.2]
Opioids	541	8.5	[7.8, 9.2]	137	15.3	[13.0, 17.7]	678	9.3	[8.7, 10.0]
Antidepressants	64	1.0	[0.8, 1.3]	10	1.1	[0.6, 2.0]	74	1.0	[0.8, 1.3]
Over-the-Counter	106	1.7	[1.4, 2.0]	39	4.3	[3.2, 5.8]	145	2.0	[1.7, 2.3]
Other Drugs	97	1.5	[1.2, 1.8]	36	4.0	[2.9, 5.4]	133	1.8	[1.5, 2.2]
Positive for Any Drug	3,456	54.2	[52.9, 55.4]	607	67.7	[64.6, 70.7]	4,063	55.8	[54.7, 57.0]
Drug Negative	2,926	45.8	[44.6, 47.1]	290	32.3	[29.3, 35.4]	3,216	44.2	[43.0, 45.3]
Positive for 2 or More Drug Categories	1,163	18.2	[17.3, 19.2]	286	31.9	[28.9, 35.0]	1,449	19.9	[19.0, 20.8]

^Active THC (Δ-9-THC or 11-OH-THC).

Notes: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel. This table combines data from all road users (e.g., drivers, pedestrians, bicyclists) included in the study.

Overall, 67.7% of the ME cases tested positive for any drug compared to 54.2% for trauma center cases. The ME cases tended to have higher raw drug positivity rates than trauma center cases for each drug category. Given the differences in study protocols by case source and the fact that ME cases were only available from 4 sites (with the great majority of ME cases coming from Maryland), results for trauma center and ME cases are presented separately throughout this report. Comparisons of trauma center and ME case drug positivity rates should be made with caution because of these limitations.

Drug Prevalence by Position in Crash

For descriptive comparison purposes, Table 8 provides drug prevalence results broken out by position in crash (i.e., driver, pedestrian, and bicyclist) for the seven study trauma centers combined across the entire study period. No statistical comparisons are made because of the substantial differences in sample sizes by position in crash and low cell counts for some drug categories. Overall, 54.4% of drivers (including motorcyclists), 54.6% of pedestrians, 54.1% of

passengers, 43.1% of bicyclists, and 61.0% of other (e.g., moped, ATV, electric kick scooter; unknown position) roadway users presenting to the trauma centers tested positive for one or more drugs included on the study's drug panel. Drug category positivity does appear to vary somewhat by position in crash. For drivers, the most prevalent drug category was cannabinoids (active THC) at 25.0%, followed by alcohol at 21.6%, and stimulants at 9.8%. Additionally, 18.1% of the total trauma center driver cases tested positive for two or more categories of drugs. Pedestrians showed a somewhat different pattern with alcohol being the most prevalent at 24.7%, followed by cannabinoids at 21.5%, and stimulants at 13.7%. For pedestrians, 20.1% tested positive for two or more categories. The other positions in crash also showed variations in drug category prevalence.

Table 9 includes drug prevalence results by position in crash for ME cases. Overall, 68.8% of drivers, 68.6% of pedestrians, 64.2% of passengers, 56.5% of bicyclists, and 52.9% of other roadway users presenting to the MEs tested positive for one or more drugs included on the study's panel. For drivers presenting to the MEs, alcohol was the most prevalent at 38.9%, followed by cannabinoids at 31.7%, and opioids at 13.0%. Additionally, 33.9% of the ME driver cases tested positive for two or more categories of drugs. Pedestrians presenting to the MEs showed a slightly different pattern with alcohol being the most prevalent at 35.7%, followed by opioids at 22.2%, and cannabinoids at 17.4%. ME pedestrian cases tested positive for two or more categories of drugs 33.8% of the time. The other positions in crash also showed variations in drug category prevalence, but the sample sizes were small for these categories of road users for the ME cases.

Additional tables in Appendix A provide trauma center and ME results broken out for each study site and position in crash. Comparisons across sites should be made with caution for a number of factors including differences in study start dates at each site and total number of cases collected at each.

The remainder of this report focuses on results for drivers only because of the known potentially impairing effects of the studied drugs on motor vehicle operators. Results are combined across study sites for the entire study period to provide an examination of drug prevalence among a large sample of drivers. Any statistical analyses presented should be interpreted with caution as they are intended to only examine potential associations of drug positivity with other variables of interest for the trauma center and ME cases separately. No statistical inferences should be made beyond this study's sample and participating sites given the site selection approach and overall study design.

Table 8. Trauma Center Cases: Positive for Drug Category by Position in Crash

	Driver (*n* =4,243)			**Passenger (*n* =936)**			**Bicyclist (*n* =232)**			**Pedestrian (*n* =776)**			**All Other (*n* =195)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	917	21.6	[20.4, 22.9]	160	17.1	[14.8, 19.6]	38	16.4	[12.0, 21.5]	192	24.7	[21.8, 27.9]	57	29.2	[23.2, 35.9]
Cannabinoids^	1,061	25.0	[23.7, 26.3]	255	27.2	[24.5, 30.2]	40	17.2	[12.8, 22.5]	167	21.5	[18.7, 24.5]	56	28.7	[22.7, 35.3]
Stimulants	417	9.8	[9.0, 10.8]	108	11.5	[9.6, 13.7]	26	11.2	[7.6, 15.7]	106	13.7	[11.4, 16.2]	18	9.2	[5.8, 13.9]
Sedatives	319	7.5	[6.8, 8.3]	66	7.1	[5.5, 8.8]	8	3.4	[1.6, 6.4]	66	8.5	[6.7, 10.6]	16	8.2	[5.0, 12.7]
Opioids	367	8.6	[7.8, 9.5]	87	9.3	[7.6, 11.3]	14	6.0	[3.5, 9.7]	56	7.2	[5.6, 9.2]	17	8.7	[5.4, 13.3]
Antidepressants	50	1.2	[0.9, 1.5]	4	0.4	[0.1, 1.0]	2	0.9	[0.2, 2.7]	6	0.8	[0.3, 1.6]	2	1.0	[0.2, 3.2]
Over-the-Counter	63	1.5	[1.2, 1.9]	19	2.0	[1.3, 3.1]	3	1.3	[0.4, 3.4]	20	2.6	[1.6, 3.9]	1	0.5	[0.1, 2.4]
Other Drugs	63	1.5	[1.2, 1.9]	11	1.2	[0.6, 2.0]	3	1.3	[0.4, 3.4]	16	2.1	[1.2, 3.2]	4	2.1	[0.7, 4.8]
Positive for Any Drug	2,307	54.4	[52.9, 55.9]	506	54.1	[50.9, 57.2]	100	43.1	[36.8, 49.5]	424	54.6	[51.1, 58.1]	119	61.0	[54.1, 67.7]
Drug Negative	1,936	45.6	[44.1, 47.1]	430	45.9	[42.8, 49.1]	132	56.9	[50.5, 63.2]	352	45.4	[41.9, 48.9]	76	39.0	[32.3, 45.9]
Positive for 2 or More Drug Categories	768	18.1	[17.0, 19.3]	164	17.5	[15.2, 20.1]	29	12.5	[8.7, 17.2]	156	20.1	[17.4, 23.0]	46	23.6	[18.0, 29.9]

^Active THC (Δ-9-THC or 11-OH-THC).

Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table 9. ME Cases: Positive for Drug Category by Position in Crash

	Driver (*n* =555)			**Passenger (*n* =95)**			**Bicyclist (*n* =23)**			**Pedestrian (*n* =207)**			**All Other (*n* =17)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	216	38.9	[34.9, 43.0]	25	26.3	[18.3, 35.8]	2	8.7	[1.9, 25.1]	74	35.7	[29.5, 42.4]	4	23.5	[8.5, 46.7]
Cannabinoids^	176	31.7	[27.9, 35.7]	27	28.4	[20.1, 38.0]	7	30.4	[14.8, 50.7]	36	17.4	[12.7, 23.0]	5	29.4	[12.2, 53.0]
Stimulants	70	12.6	[10.0, 15.6]	10	10.5	[5.5, 17.9]	3	13.0	[3.8, 30.9]	27	13.0	[9.0, 18.1]	2	11.8	[2.5, 32.7]
Sedatives	40	7.2	[5.3, 9.6]	8	8.4	[4.1, 15.3]	0	0.0	[0.0, 0.0]	25	12.1	[8.2, 17.0]	0	0.0	[0.0, 0.0]
Opioids	72	13.0	[10.4, 16.0]	13	13.7	[7.9, 21.6]	4	17.4	[6.2, 36.2]	46	22.2	[17.0, 28.2]	2	11.8	[2.5, 32.7]
Antidepressants	4	0.7	[0.3, 1.7]	2	2.1	[0.4, 6.6]	0	0.0	[0.0, 0.0]	4	1.9	[0.7, 4.5]	0	0.0	[0.0, 0.0]
Over-the-Counter	25	4.5	[3.0, 6.5]	3	3.2	[0.9, 8.2]	0	0.0	[0.0, 0.0]	11	5.3	[2.9, 9.0]	0	0.0	[0.0, 0.0]
Other Drugs	27	4.9	[3.3, 6.9]	2	2.1	[0.4, 6.6]	0	0.0	[0.0, 0.0]	7	3.4	[1.5, 6.5]	0	0.0	[0.0, 0.0]
Positive for Any Drug	382	68.8	[64.9, 72.6]	61	64.2	[54.3, 73.3]	13	56.5	[36.5, 75.0]	142	68.6	[62.1, 74.6]	9	52.9	[30.3, 74.6]
Drug Negative	173	31.2	[27.4, 35.1]	34	35.8	[26.7, 45.7]	10	45.7	[25.0, 63.5]	65	31.4	[25.4, 37.9]	8	47.1	[25.4, 69.7]
Positive for 2 or More Drug Categories	188	33.9	[30.0, 37.9]	21	22.1	[14.7, 31.2]	3	13.0	[3.8, 30.9]	70	33.8	[27.6, 40.5]	4	23.5	[8.5, 46.7]

^Active THC (Δ-9-THC or 11-OH-THC).

Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Driver Drug Prevalence

Sex. As shown in Table 10 for the trauma center driver cases, sex was reliably associated with drug positivity for alcohol and five of the other drug classes (*ps* < .05). Males in this study's sample had higher prevalence rates for alcohol, cannabinoids (active THC), and stimulants compared to females. Females showed higher prevalence rates for sedatives, antidepressants, and OTC drugs compared to males.

Table 10. Trauma Center Cases: Drivers Positive for Drug Category by Sex

	Males (*n* =2,985)			**Females (*n* =1,246)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI
Alcohol	721	24.2*	[22.6, 25.7]	192	15.4	[13.5, 17.5]
Cannabinoids^	800	26.8*	[25.2, 28.4]	259	20.8	[18.6, 23.1]
Stimulants	324	10.9*	[9.8, 12.0]	92	7.4	[6.0, 8.9]
Sedatives	200	6.7	[5.8, 7.6]	117	9.4*	[7.9, 11.1]
Opioids	254	8.5	[7.5, 9.6]	111	8.9	[7.4, 10.6]
Antidepressants	22	0.7	[0.5, 1.1]	28	2.2*	[1.5, 3.2]
Over-the-Counter	32	1.1	[0.7, 1.5]	31	2.5*	[1.7, 3.5]
Other Drugs	50	1.7	[1.3, 2.2]	12	1.0	[0.5, 1.6]
Positive for Any Drug	1,709	57.3*	[55.5, 59.0]	589	47.3	[44.5, 50.0]
Drug Negative	1,276	42.7	[41.0, 44.5]	657	52.7*	[50.0, 55.5]
Positive for 2 or More Drug Categories	565	18.9	[17.6, 20.4]	201	16.1	[14.2, 18.3]

^Active THC (Δ-9-THC or 11-OH-THC). *Significantly higher ($p < .05$).
Notes: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel. Sex was unknown for 12 cases.

Table 11 shows that for the ME driver cases, sex was associated with overall drug prevalence with males (70.6%) having higher overall prevalence than females (60.0%). The relatively small number of females limited the power of the statistical analyses for the individual drug categories.

Table 11. ME Cases: Drivers Positive for Drug Category by Sex

	Males (*n* =445)			**Females (*n* =105)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI
Alcohol	179	40.2	[35.7, 44.8]	34	32.4	[24.0, 41.7]
Cannabinoids^	145	32.6	[28.4, 37.0]	29	27.6	[19.8, 36.7]
Stimulants	50	11.2	[8.6, 14.4]	18	17.1	[10.9, 25.2]
Sedatives	31	7.0	[4.9. 9.6]	9	8.6	[4.3, 15.1]
Opioids	58	13.0	[10.1, 16.4]	12	11.4	[6.4, 18.5]
Antidepressants	1	0.2	[0.0, 1.0]	3	2.9*	[0.8, 7.4]
Over-the-Counter	18	4.0	[2.5, 6.2]	7	6.7	[3.0, 12.6]
Other Drugs	20	4.5	[2.9, 6.7]	7	6.7	[3.0, 12.6]
Positive for Any Drug	314	70.6*	[66.2, 74.7]	63	60.0	[50.5, 69.0]
Drug Negative	131	29.4	[25.3, 33.8]	42	40.0*	[31.0, 49.5]
Positive for 2 or More Drug Categories	145	32.6	[28.4, 37.0]	40	38.1	[29.2, 47.6]

^Active THC (Δ-9-THC or 11-OH-THC). *Significantly higher ($p < .05$).
Notes: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel. Sex was unknown for 5 cases. Small cell counts limit the validity of some statistical comparisons.

Age. Table 12 includes drug category positivity counts and rates broken out by selected age groups for the trauma center driver cases. The age groups showed notably different patterns in drug category positivity. The 21-34 and 35-44 age groups were most likely to test positive for any drug at 64.3% and 58.3% respectively. Similarly, the 21-34 and 35-44 age groups were most likely to test positive for two or more categories at 21.5% and 20.5% respectively. Notably, 40.7% of the 18-20 age group and 38.7% of the 21-34 age group tested positive for cannabinoids with the older age groups less likely to test positive for cannabinoids. The 35-44 age group was most likely to test positive for alcohol at 25.5% with 21-to-34-year-olds showing similar prevalence with 24.8% alcohol positive. The 45-64 age group was most likely to test positive for opioids at 11.1%. The 65 and older age group showed the highest rates of positivity for sedatives (9.1%), antidepressants (3.4%), and OTC drugs (3.0%).

Table 12. Trauma Center Cases: Drivers Positive for Drug Category by Age Group

	18-20 (*n* =243)			**21-34 (*n* =1,586)**			**35-44 (*n* =781)**			**45-64 (*n* =1,156)**			65+ (*n* =470)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	37	15.2	[11.1, 20.1]	394	24.8[A,E]	[22.8, 27.0]	199	25.5[A,E]	[22.5, 28.6]	240	20.8[E]	[18.5, 23.2]	44	9.4	[7.0, 12.2]
Cannabinoids^	99	40.7[C,D,E]	[34.7, 47.0]	613	38.7[C,D,E]	[36.3, 41.1]	174	22.3[D,E]	[19.5, 25.3]	144	12.5[E]	[10.6, 14.5]	30	6.4	[4.4, 8.9]
Stimulants	4	1.6	[0.6, 3.9]	171	10.8[A,E]	[9.3, 12.4]	106	13.6[A,E]	[11.3, 16.1]	122	10.6[A,E]	[8.9, 12.4]	14	3.0	[1.7, 4.8]
Sedatives	6	2.5	[1.0, 5.0]	101	6.4	[5.2, 7.7]	64	8.2[A]	[6.4, 10.3]	103	8.9[A]	[7.4, 10.7]	43	9.1[A]	[6.8, 12.0]
Opioids	7	2.9	[1.3, 5.6]	119	7.5	[6.3, 8.9]	74	9.5[A]	[7.6, 11.7]	128	11.1[A,B]	[9.4, 13.0]	39	8.3	[6.1, 11.0]
Antidepressants	1	0.4	[0.0, 1.9]	6	0.4	[0.2, 0.8]	9	1.2	[0.6, 2.1]	18	1.6[B]	[1.0, 2.4]	16	3.4[B]	[2.0, 5.3]
Over-the-Counter	1	0.4	[0.0, 1.9]	16	1.0	[0.6, 1.6]	10	1.3	[0.7, 2.3]	22	1.9	[1.2, 2.8]	14	3.0[B]	[1.7, 4.8]
Other Drugs	2	0.8	[0.2, 2.6]	21	1.3	[0.8, 2.0]	17	2.2	[1.3, 3.4]	20	1.7	[1.1, 2.6]	2	0.4	[0.1, 1.4]
Positive for Any Drug	121	49.8[E]	[43.5, 56.1]	1,020	64.3[A,D,E]	[61.9, 66.6]	455	58.3[D,E]	[54.8, 61.7]	555	48.0[E]	[45.1, 50.9]	152	32.3	[28.2, 36.7]
Drug Negative	122	50.2[B]	[43.9, 56.5]	566	35.7	[33.4, 38.1]	326	41.7	[38.3, 45.2]	601	52.0[B,C]	[49.1, 54.9]	318	67.7[A,B,C,D]	[63.3, 71.8]
Positive for 2 or More Drug Categories	30	12.3	[8.7, 16.9]	341	21.5[A,D,E]	[19.5, 23.6]	160	20.5[E]	[17.8, 23.4]	191	16.5[E]	[14.5, 18.7]	44	9.4	[7.0, 12.2]

^Active THC (Δ-9-THC or 11-OH-THC). [A] Significantly higher ($p < .05$) than 18-20 age group. [B] Significantly higher ($p < .05$) than 21-34 age group. [C] Significantly higher ($p < .05$) than 35-44 age group. [D] Significantly higher ($p < .05$) than 45-64 age group. [E] Significantly higher ($p < .05$) than 65 and older age group.
Notes: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel. Age was unknown for 7 cases. Small cell counts limit the validity of some statistical comparisons.

Table 13 provides drug category positivity counts and rates broken out by age group for the ME driver cases. It is important to note that small cell counts for some age groups and drug categories limit the validity of any statistical comparisons using those counts. Overall, the 35-44 age group showed the highest percentage testing positive for any drug at 79.2% with 21-to-34-year-olds almost as high at 76.3%. The 21-34 age group, however, had the highest positivity rate for two or more categories of drugs for ME cases at 41.5% followed by the 35-to-44-year-olds at 38.5% and the 45-64 age group at 30.1%. Notably, 49.8% of the 21-34 age group and 44.8% of the 35-to-44-year-olds tested positive for alcohol. Cannabinoid positivity was also high for 21—to-34-year-olds (41.5%), 35-to-44-year-olds (38.5%), and 18-to-20-year-olds (38.7%). The 35-44 age group showed the highest positivity rate for opioids among ME cases at 22.9% while the 65 and older age group had the highest rate of OTC drug positivity at 13.8%.

Table 13. ME Cases: Drivers Positive for Drug Category by Age Group

	18-20 (*n* =31)			**21-34 (*n* =207)**			**35-44 (*n* =96)**			**45-64 (*n* =153)**			65+ (*n* =58)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	5	16.1	[6.4, 31.8]	103	49.8[A,D,E]	[43.0, 56.5]	43	44.8[E]	[35.1, 54.8]	49	32.0	[25.0, 39.7]	8	13.8	[6.7, 24.3]
Cannabinoids^	12	38.7[E]	[23.2, 56.2]	86	41.5[D,E]	[35.0, 48.3]	37	38.5[D,E]	[29.3, 48.5]	32	20.9	[15.1, 27.9]	5	8.6	[3.4, 17.9]
Stimulants	3	9.7	[2.8, 23.6]	29	14.0	[9.8, 19.2]	8	8.3	[4.0, 15.1]	25	16.3	[11.1, 22.8]	4	6.9	[2.4, 15.6]
Sedatives	2	6.5	[1.4, 19.1]	18	8.7	[5.4, 13.1]	5	5.2	[2.0, 11.0]	13	8.5	[4.8, 13.7]	2	3.4	[0.7, 10.6]
Opioids	3	9.7	[2.8, 23.6]	20	9.7	[6.2, 14.2]	22	22.9[B]	[15.4, 32.0]	20	13.1	[8.4, 19.1]	6	10.3	[4.4, 20.1]
Antidepressants	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	2	1.3	[0.3, 4.1]	2	3.4	[0.7, 10.6]
Over-the-Counter	0	0.0	[0.0, 0.0]	2	1.0	[0.2, 3.1]	6	6.3[B]	[2.7, 12.4]	9	5.9[B]	[3.0, 10.5]	8	13.8[B]	[6.7, 24.3]
Other Drugs	3	9.7	[2.8, 23.6]	7	3.4	[1.5, 6.5]	6	6.3	[2.7, 12.4]	10	6.5	[3.4, 11.1]	1	1.7	[0.2, 7.8]
Positive for Any Drug	18	58.1	[40.6, 74.1]	158	76.3[E]	[70.2, 81.7]	76	79.2[E]	[70.3, 86.4]	97	63.4	[55.6, 70.7]	25	43.1	[31.0, 55.9]
Drug Negative	13	41.9	[25.9, 59.4]	49	23.7	[18.3, 29.8]	20	20.8	[13.6, 29.7]	56	36.6	[29.3, 44.4]	33	56.9[B,C]	[44.1, 69.0]
Positive for 2 or More Drug Categories	6	19.4	[8.5, 35.6]	86	41.5[E]	[35.0, 48.3]	37	38.5[E]	[29.3, 48.5]	46	30.1	[23.2, 37.7]	8	13.8	[6.7, 24.3]

^Active THC (Δ-9-THC or 11-OH-THC). [A] Significantly higher ($p < .05$) than 18-20 age group. [B] Significantly higher ($p < .05$) than 21-34 age group.
[C] Significantly higher ($p < .05$) than 35-44 age group. [D] Significantly higher ($p < .05$) than 45-64 age group. [E] Significantly higher ($p < .05$) than 65+ age group.
Notes: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel. Age was unknown for 10 cases. Small cell counts limit the validity of some statistical comparisons.

Daytime/Nighttime. To be consistent with the FARS definition of night and day, nighttime was defined as 6 p.m. to 5:59 a.m. and daytime from 6 a.m. to 5:59 p.m.[8] Table 14 shows that for trauma center driver cases, the percentage of drivers testing positive for any drug was higher for nighttime crashes (66.0%) than for daytime crashes (45.0%). Similarly, drivers crashing at night were more likely to test positive for two or more drug categories than drivers crashing during the day (23.4% versus 13.8%). There was a difference in alcohol positivity with drivers at night (35.7%) being more likely to test positive than drivers during the day (10.3%). Cannabinoids, stimulants, and other drugs prevalence were also higher at night than during the day for trauma center driver cases, but sedative and opioid prevalence were higher during the day than at night.

Table 14. Trauma Center Cases: Drivers Positive for Drug Category by Day/Night

	Daytime (*n* =2,348)			**Nighttime (*n* =1,895)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI
Alcohol	241	10.3	[9.1, 11.5]	676	35.7*	[33.5, 37.9]
Cannabinoids^	501	21.3	[19.7, 23.0]	560	29.6*	[27.5, 31.6]
Stimulants	200	8.5	[7.4, 9.7]	217	11.5*	[10.1, 12.9]
Sedatives	196	8.3*	[7.3, 9.5]	123	6.5	[5.4, 7.7]
Opioids	221	9.4*	[8.3, 10.6]	146	7.7	[6.6, 9.0]
Antidepressants	33	1.4	[1.0, 1.9]	17	0.9	[0.5, 1.4]
Over-the-Counter	40	1.7	[1.2, 2.3]	23	1.2	[0.8, 1.8]
Other Drugs	27	1.1	[0.8, 1.6]	36	1.9*	[1.4, 2.6]
Positive for Any Drug	1,056	45.0	[43.0, 47.0]	1,251	66.0*	[63.9, 68.1]
Drug Negative	1,292	55.0*	[53.0, 57.0]	644	34.0	[31.9, 36.1]
Positive for 2 or More Drug Categories	324	13.8	[12.4, 15.2]	444	23.4*	[21.6, 25.4]

^Active THC (Δ-9-THC or 11-OH-THC). *Significantly higher ($p < .05$).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

[8] When a crash time was not available for a case, time of arrival at the trauma center was used as the approximate crash time.

Table 15 shows that for ME driver cases, the percentage of drivers testing positive for any drug was higher for nighttime crashes (76.4%) than for daytime crashes (58.4%). Drivers crashing at night were also significantly more likely to test positive for two or more drug categories than drivers crashing during the day (38.2% versus 27.9%). Alcohol positivity was higher for ME cases who crashed at night (54.3%) versus during the day (17.6%). Cannabinoids were also higher at night (35.4%) than during the day (26.6%). Other drugs prevalence (7.3%) was higher during the day than at night (3.1%).

Table 15. ME Cases: Drivers Positive for Drug Category by Day/Night

	Daytime (*n* =233)			Nighttime (*n* =322)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI
Alcohol	41	17.6	[13.1, 22.9]	175	54.3*	[48.9, 59.7]
Cannabinoids^	62	26.6	[21.2, 32.5]	114	35.4*	[30.3, 40.7]
Stimulants	30	12.9	[9.0, 17.6]	40	12.4	[9.2, 16.4]
Sedatives	21	9.0	[5.8, 13.2]	19	5.9	[3.7, 8.9]
Opioids	37	15.9	[11.6, 21.0]	35	10.9	[7.8, 14.6]
Antidepressants	3	1.3	[0.4, 3.4]	1	0.3	[0.0, 1.4]
Over-the-Counter	15	6.4	[3.8, 10.1]	10	3.1	[1.6, 5.4]
Other Drugs	17	7.3*	[4.5, 11.2]	10	3.1	[1.6, 5.4]
Positive for Any Drug	136	58.4	[52.0, 64.6]	246	76.4*	[71.5, 80.8]
Drug Negative	97	41.6*	[35.4, 48.0]	76	23.6	[19.2, 28.5]
Positive for 2 or More Drug Categories	65	27.9	[22.4, 33.9]	123	38.2*	[33.0, 43.6]

^Active THC (Δ-9-THC or 11-OH-THC). *Significantly higher ($p < .05$).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Weekday/Weekend. Consistent with FARS, this study defined the weekend as 6 p.m. Friday to 5:59 a.m. on Monday. Weekday was defined as 6 a.m. Monday to 5:59 p.m. on Friday. As shown in Table 16, drivers who presented to the trauma centers on the weekend were more likely than weekday drivers to test positive for any drug (63.9% versus 49.8%) and for two or more drug categories (21.6% versus 16.4%). For the individual drug categories, weekend drivers at the trauma centers were more likely than weekday drivers to test positive for alcohol (35.1% versus 15.1%). Positivity rates were fairly similar for all of the other individual drug categories.

Table 16. Trauma Center Cases: Drivers Positive for Drug Category by Weekday/Weekend

	Weekday (*n* =2,857)			Weekend (*n* =1,386)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI
Alcohol	430	15.1	[13.8, 16.4]	487	35.1*	[32.7, 37.7]
Cannabinoids^	689	24.1	[22.6, 25.7]	372	26.8	[24.6, 29.2]
Stimulants	280	9.8	[8.8, 10.9]	137	9.9	[8.4, 11.5]
Sedatives	221	7.7	[6.8, 8.8]	98	7.1	[5.8, 8.5]
Opioids	254	8.9	[7.9, 10.0]	113	8.2	[6.8, 9.7]
Antidepressants	39	1.4	[1.0, 1.8]	11	0.8	[0.4, 1.4]
Over-the-Counter	49	1.7	[1.3, 2.2]	14	1.0	[0.6, 1.6]
Other Drugs	36	1.3	[0.9, 1.7]	27	1.9	[1.3, 2.8]
Positive for Any Drug	1,422	49.8	[47.9, 51.6]	885	63.9*	[61.3, 66.4]
Drug Negative	1,435	50.2*	[48.4, 52.1]	501	36.1	[33.6, 38.7]
Positive for 2 or More Drug Categories	468	16.4	[15.1, 17.8]	300	21.6*	[19.5, 23.9]

^Active THC (Δ-9-THC or 11-OH-THC). *Significantly higher ($p < .05$).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table 17 provides drug category prevalence data for drivers presenting to the MEs on weekdays versus weekends. Weekend ME case drivers were more likely than weekday drivers to test positive for any drug (74.6% versus 63.9%). For the individual drug categories, weekend ME case drivers were more likely to test positive for alcohol (50.0% versus 29.4%) while weekday drivers were more likely to test positive for opioids (16.1% versus 9.4%).

Table 17. ME Cases: Drivers Positive for Drug Category by Weekday/Weekend

	Weekday (*n* =299)			Weekend (*n* =256)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI
Alcohol	88	29.4	[24.5, 34.8]	128	50.0*	[43.9, 56.1]
Cannabinoids^	94	31.4	[26.4, 36.9]	82	32.0	[26.5, 37.9]
Stimulants	37	12.4	[9.0, 16.5]	33	12.9	[9.2, 17.4]
Sedatives	25	8.4	[5.6, 11.9]	15	5.9	[3.5, 9.2]
Opioids	48	16.1*	[12.2, 20.5]	24	9.4	[6.3, 13.4]
Antidepressants	3	1.0	[0.3, 2.7]	1	0.4	[0.0, 1.8]
Over-the-Counter	17	5.7	[3.5, 8.7]	8	3.1	[1.5, 5.8]
Other Drugs	15	5.0	[3.0, 7.9]	12	4.7	[2.6, 7.8]
Positive for Any Drug	191	63.9	[58.3, 69.2]	191	74.6*	[69.0, 79.5]
Drug Negative	108	36.1*	[30.8, 41.7]	65	25.4	[20.4, 31.0]
Positive for 2 or More Drug Categories	98	32.8	[27.6, 38.2]	90	35.2	[29.5, 41.1]

^Active THC (Δ-9-THC or 11-OH-THC). *Significantly higher ($p < .05$).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Alcohol Concentrations. Table 18 shows counts and percentages of trauma center, ME, and total driver cases by selected BAC ranges. Of the trauma center driver cases who were BAC positive (BAC $\geq$ .02 g/dL; $n = 917$), 83.4% had a BAC at or above .08 g/dL. Of the ME driver cases who were BAC positive (BAC $\geq$ .02 g/dL; $n = 216$), 87.0% had a BAC at or above .08 g/dL.

Table 18. Driver BAC Ranges by Case Source

	Trauma Center (*n* =4,243)			**Medical Examiner (*n* =555)**			**Total (*N* =4,798)**		
BAC Range	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Negative	3,326	78.4	[77.1, 79.6]	339	61.1	[57.0, 65.1]	3,665	76.4	[75.2, 77.6]
.02 - .049	78	1.8	[1.5, 2.3]	17	3.1	[1.9, 4.7]	95	2.0	[1.6, 2.4]
.05 - .079	74	1.7	[1.4, 2.2]	11	2.0	[1.1, 3.4]	85	1.7	[1.4, 2.2]
.08 - .149	229	5.4	[4.7, 6.1]	43	7.7	[5.7, 10.2]	272	5.7	[5.0, 6.4]
.15+	536	12.7	[11.7, 13.7]	145	26.1	[22.6, 29.9]	681	14.2	[13.2, 15.2]

Alcohol Combined With Other Drug Categories. Table 19 provides counts and percentages for trauma center, ME, and total driver cases testing positive for alcohol alone and in combination with other drug categories. Percentages are based on the total driver case counts for each source. Overall, 11.7% of the trauma center and 16.0% of the ME case drivers tested positive for alcohol alone. Alcohol was combined with one other category of drugs for 7.6% of the trauma center and 17.7% of the ME case drivers with cannabinoids (4.8% and 12.3% respectively) being the most frequent pairing. Among the trauma center case drivers who were alcohol positive (n = 917), 45.8% had one or more other drugs detected compared to 58.8% for the ME case drivers who were alcohol positive (n = 216).

Table 19. Driver Alcohol and Other Drug Category Combinations by Case Source

	Trauma Center (n =4,243)			**Medical Examiner (n =555)**			**Total (N =4,798)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol Only	497	11.7	[10.8, 12.7]	89	16.0	[13.2, 19.3]	586	12.2	[11.3, 13.2]
Alcohol + 1 Other Category	324	7.6	[6.9, 8.5]	98	17.7	[14.7, 21.0]	422	8.8	[8.0, 9.6]
*Cannabinoids^*	*205*	*4.8*	*[4.2, 5.5]*	*68*	*12.3*	*[9.7, 15.2]*	*273*	*5.7*	*[5.1, 6.4]*
Stimulants	*45*	*1.1*	*[0.8, 1.4]*	*16*	*2.9*	*[1.7, 4.5]*	*61*	*1.3*	*[1.0, 1.6]*
Sedatives	*35*	*0.8*	*[0.6, 1.1]*	*3*	*0.5*	*[0.2, 1.4]*	*38*	*0.8*	*[0.6, 1.1]*
Opioids	*20*	*0.5*	*[0.3, 0.7]*	*4*	*0.7*	*[0.2, 1.7]*	*24*	*0.5*	*[0.3, 0.7]*
Antidepressants	*2*	*0.0*	*[0.0, 0.2]*	*1*	*0.2*	*[0.0, 0.8]*	*3*	*0.1*	*[0.0, 0.2]*
Over-the-Counter	*8*	*0.2*	*[0.1, 0.4]*	*3*	*0.5*	*[0.2, 1.4]*	*11*	*0.2*	*[0.1, 0.4]*
Other Drugs	*9*	*0.2*	*[0.1, 0.4]*	*3*	*0.5*	*[0.2, 1.4]*	*12*	*0.3*	*[0.1, 0.4]*
Alcohol + 2 or More Other Categories	96	2.3	[1.8, 2.7]	29	5.2	[3.6, 7.3]	125	2.6	[2.2, 3.1]

^Active THC (Δ-9-THC or 11-OH-THC). Sub-counts of alcohol + 1 other category are italicized.

Cannabinoid Concentrations. Table 20 displays the counts and percentages of trauma center and ME drivers by selected total active THC (Δ-9-THC + *11-OH-THC*) concentration ranges. Of the trauma center driver cases who tested positive for THC (*n* = 1,061), 80.0% had a concentration at or above 2 ng/mL, and 50.6% had a concentration at or above 5 ng/mL. Of the ME driver cases who tested positive for THC (*n* = 176), 86.4% had a concentration at or above 2 ng/mL, and 63.6% had a concentration at or above 5 ng/mL.

Table 20. Driver Active Cannabinoid Concentration Ranges

	Trauma Center (*n* =4,243)			**Medical Examiner (*n* =555)**			**Total (*n* 4,798)**		
THC Range	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Negative	3,182	75.0	[73.7, 76.3]	379	68.3	[64.3, 72.1]	3,561	74.2	[73.0, 75.4]
1 ng/mL	212	5.0	[4.4, 5.7]	24	4.3	[2.9, 6.3]	236	4.9	[4.3, 5.6]
2-4 ng/mL	312	7.3	[6.6, 8.2]	40	7.2	[5.3, 9.6]	352	7.3	[6.6, 8.1]
5-9 ng/mL	275	6.5	[5.8, 7.3]	41	7.4	[5.4, 9.8]	316	6.6	[5.9, 7.3]
≥10 ng/mL	262	6.2	[5.5, 6.9]	71	12.8	[10.2, 15.8]	333	6.9	[6.2, 7.7]

Cannabinoids Combined With Other Drug Categories. Table 21 provides counts and percentages for trauma center, ME, and total driver cases positive for cannabinoids alone and in combination with alcohol or other drug categories. Overall, 14.2% of the trauma center and 9.2% of the ME case drivers tested positive for cannabinoids alone. Cannabinoids were combined with one other category of drugs for 8.3% of the trauma center and 15.5% of the ME case drivers with alcohol (4.8% and 12.3% respectively) being the most frequent pairing. Among the trauma center case drivers who were cannabinoids positive (*n* = 1,061), 43.4% had one or more other drugs detected compared to 71.0% for the ME case drivers who were cannabinoids positive (*n* = 176).

Table 21. Driver Cannabinoids and Other Drug Category Combinations by Case Source

	Trauma Center (*n* =4,243)			**Medical Examiner (*n* =555)**			**Total (*N* =4,798)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Cannabinoids^ Only	601	14.2	[13.1, 15.2]	51	9.2	[7.0, 11.8]	652	13.6	[12.6, 14.6]
Cannabinoids^ + 1 Other Category	353	8.3	[7.5, 9.2]	86	15.5	[12.7, 18.7]	439	9.1	[8.4, 10.0]
Alcohol	*205*	*4.8*	*[4.2, 5.5]*	*68*	*12.3*	*[9.7, 15.2]*	*273*	*5.7*	*[5.1, 6.4]*
Stimulants	*62*	*1.5*	*[1.1, 1.9]*	*4*	*0.7*	*[0.2, 1.7]*	*66*	*1.4*	*[1.1, 1.7]*
Sedatives	*27*	*0.6*	*[0.4, 0.9]*	*3*	*0.5*	*[0.2, 1.4]*	*30*	*0.6*	*[0.4, 0.9]*
Opioids	*48*	*1.1*	*[0.8, 1.5]*	*6*	*1.1*	*[0.5, 2.2]*	*54*	*1.1*	*[0.9, 1.5]*
Antidepressants	*0*	*0.0*	*[0.0, 0.0]*	*1*	*0.2*	*[0.0, 0.8]*	*1*	*0.0*	*[0.0, 0.1]*
Over-the-Counter	*4*	*0.1*	*[0.0, 0.2]*	*0*	*0.0*	*[0.0, 0.0]*	*4*	*0.1*	*[0.0, 0.2]*
Other Drugs	*7*	*0.2*	*[0.1, 0.3]*	*4*	*0.7*	*[0.2, 1.7]*	*11*	*0.2*	*[0.1, 0.4]*
Cannabinoids^ + 2 or More Other Categories	107	2.5	[2.1, 3.0]	39	7.0	[5.1, 9.4]	146	3.0	[2.6, 3.6]

^Active THC (Δ-9-THC or 11-OH-THC). Sub-counts of cannabinoids + 1 other drug category are italicized.

Overall Drug Positivity Excluding Alcohol and Cannabinoids. As can be seen in the above tables, alcohol and cannabinoids (active THC) are by far the most prevalent drugs. In order to examine the overall prevalence of other drugs without consideration of alcohol and cannabinoids, Table 22 provides counts and percentages for trauma center, ME, and total driver cases positive for drugs when alcohol and/or cannabis data were excluded from the analyses. As shown in the table, 23.7% of the trauma center and 31.4% of the medical examiner driver cases tested positive for at least one category of drugs other than alcohol and cannabis. Overall, 5.6% of the trauma center and 9.0% of the medical examiner driver cases tested positive for two or more categories of drugs other than alcohol and cannabis.

Table 22. Driver Drug Positivity Excluding Alcohol and Cannabinoids by Case Source

	Trauma Center (*n* =4,243)			**Medical Examiner (*n* =555)**			**Total (*N* =4,798)**		
	n	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Positive for at Least 1 Drug Category Other Than Alcohol and Cannabinoids	1,004	23.7	[22.4, 25.0]	174	31.4	[27.6, 35.3]	1,178	24.6	[23.3, 25.8]
Positive for 2 or More Drug Categories Other Than Alcohol and Cannabinoids	239	5.6	[5.0, 6.4]	50	9.0	[6.8, 11.6]	289	6.0	[5.4, 6.7]

Summary of Results

This study analyzed blood specimens from a large number of seriously or fatally injured roadway users from selected trauma centers and MEs in the United States to understand more about drug prevalence among these populations. Seven trauma centers and four MEs' offices participated in the study by providing over 7,500 suspected roadway user specimens for independent toxicological analysis. The specimens were made available as part of normal treatment or autopsy procedures shortly after crashes that allowed for the best opportunity to determine whether drugs were likely in the people's systems at the time of the crashes in which they were injured or killed.

Of the specimens provided, 7,279 were confirmed to be adult roadway users of interest (drivers, pedestrians, bicyclists, and passengers) for whom enough blood was made available within 6 hours of the crash event for complete toxicological analysis. The descriptive results showed overall drug positivity (i.e., positive for alcohol or any other drug on the study panel) was 55.8% for the entire study sample combined across all trauma centers and MEs. For trauma center cases, 54.1% of all roadway users were positive for any drug compared to 67.7% for all ME cases (see Table 7).

Breaking out the prevalence results by position in crash (e.g., driver, pedestrian, and bicyclist) showed that drug prevalence was relatively high for each group. The results in this report focused on drug prevalence for drivers (including motorcycle operators) combined across the seven trauma centers (n = 4,243) for the entire study period, and separately for drivers combined across the four participating ME offices (n = 555). The study found that 54.4% of the trauma center driver cases tested positive for one or more drugs on the study's panel with cannabinoids being the most prevalent (25.0%) followed by alcohol (21.6%). Stimulants (9.8%), opioids (8.6%), and sedatives (7.5%) were also frequently detected among trauma center cases. The

results also showed that 18.1% of the trauma center driver cases tested positive for two or more categories of drugs (see Table 8).

Drug prevalence was high among drivers who died at the scene of a crash and presented to the MEs participating in this study (see Table 9). Overall, 68.8% of the ME driver cases tested positive for one or more drugs with alcohol the most prevalent (38.9%) followed by cannabinoids (31.7%). Opioids (13.0%), stimulants (12.6%), sedatives (7.2%), OTC (4.5%), and other drugs (4.9%) were also frequently detected among ME driver cases. Also, 33.9% of the ME driver cases tested positive for two or more drug categories.

Roughly two-thirds of the entire trauma center driver sample in this study were male, which is consistent with the general trauma populations at these sites (Ngo et al., 2021) and nationally (e.g., Chang, 2016). This study found associations of driver sex with drug category positivity. For the trauma center driver cases (see Table 10), males were more likely than females to test positive for alcohol (24.2% versus 15.4%), cannabinoids (26.8% versus 20.8%), and stimulants (10.9% versus 7.4%). Females, however, were more likely to test positive for sedatives (9.4% versus 6.7%), antidepressants (2.2% versus 0.7%), and OTC drugs (2.5% versus 1.1%). For ME cases males were more likely than females to test positive for any drug (70.6% versus 60.0%). The smaller sample size for ME cases limited the power of the statistical analyses to detect reliable differences for most of the individual drug categories. From a descriptive perspective, however, males in the ME driver sample had higher positivity for alcohol than females (40.2% versus 32.4%), and cannabinoids (32.6% versus 27.6%), but females showed higher positivity for stimulants (17.1% versus 11.2%), sedatives (8.6% versus 7.0%), OTC drugs (6.7% versus 4.0%), and other drugs (6.7% versus 4.5%).

The study found associations of driver age with drug category positivity among the trauma center driver cases (see Table 12). The 21-34 and 35-44 age groups were most likely to test positive for any drug at 64.3% and 58.3% respectively, while drivers 65 and older were less likely to test positive for any drug at 32.3%. Similarly, the 21-34 and 35-44 age groups were most likely to test positive for two or more drug categories at 21.5% and 20.5% respectively, versus only 9.4% for those 65 and older. For cannabinoids, 41.0% of the 18-20 age group and 38.6% of the 21-34 age group tested positive which was higher than the other age groups. The 35-44 age group was most likely to test positive for alcohol at 25.5%. Also of note, the 45-64 age group was most likely to test positive for opioids at 11.1%, and the 65 and older age group showed the highest rates of positivity for sedatives (9.1%), antidepressants (3.4%), and OTC drugs (3.0%).

Breaking the ME driver cases into five age groups limited the validity of any statistical comparisons because of small cases counts for many of the drug categories (see Table 13). When looking at overall drug positivity among the ME driver cases, the 35-44 (79.2%) and 21-34 (76.3%) age groups had the highest rates with the 65 and older age group the lowest at 43.1%. Regarding testing positive for two or more categories, the 21-34 age group was highest at 41.5% followed by the 35-44 age group at 38.5%, and the 65 and older age group was lowest at 13.8%. Notably, 49.8% of the 21-34 age group and 44.8% of the 35-44 age group tested positive for alcohol among the ME cases. Cannabinoid positivity was also high for 21-to-34-year-olds (41.5%), 35-to-44-year-olds (38.5%), and 18-to-20-year-olds (38.7%). The 35-44 age group showed the highest positivity rate for opioids at 22.9% while the 65 and older age group had the highest rate of OTC drug positivity at 13.8% among the ME driver age groups.

Associations were also found for crash time of day and drug category positivity for drivers. For trauma center driver cases (see Table 14), the percentage of drivers testing positive for any drug was higher for nighttime crashes (66.0%) than for daytime crashes (45.0%). ME driver cases showed a similar pattern with nighttime driver positivity for any drug at 76.4% compared to 58.4% for daytime (see Table 15). The largest positivity difference for both case sources was for alcohol with nighttime alcohol positivity much higher than daytime.

In addition, drivers who presented to the trauma centers on the weekend were more likely than weekday drivers to test positive for any drug (63.9% versus 49.8%) and for two or more drug categories (21.6% versus 16.4%; see Table 16). Weekend drivers at the trauma centers were more likely than weekday drivers to test positive for alcohol (35.1% versus 15.1%). ME driver cases followed a similar pattern (see Table 170) with weekend drivers more likely than weekday drivers to test positive for any drug (74.6% versus 63.9%). For the individual drug categories, weekend ME driver cases had higher alcohol positivity than weekday drivers (50.0% versus 29.4%), but weekday drivers were more likely than weekend drivers to test positive for opioids (16.1% versus 9.4%).

The study also examined BACs among drivers who tested positive for alcohol. Of those trauma center and ME driver cases who were BAC-positive (see Table 180), 83.4% and 87.0%, respectively, had BACs at or above .08 g/dL. In addition, 7.6% of the trauma center drivers and 17.7% of the ME driver cases tested positive for alcohol combined with at least one other category of drugs, with cannabinoids being the most frequent pairing for both (see Table 19).

Regarding cannabinoid concentrations among those who tested positive (see Table 20), 80.0% of the trauma center driver cases and 86.4% of the ME driver cases had active THC concentrations at or above 2 ng/mL. Of the trauma center driver cases, 50.6% had concentrations at or above 5 ng/mL, and ME driver cases had 63.6% with concentrations at or above 5 ng/mL. Overall, 8.3% of the trauma center and 15.5% of the ME driver cases tested positive for cannabinoids combined with other drugs, with alcohol being the most frequent pairing for both (Table 21).

A final analysis looked at overall driver drug positivity when alcohol and cannabis results were not considered as part of the drug prevalence calculations (Table 22). The analyses revealed that 23.7% of the trauma center and 31.4% of the medical examiner driver cases tested positive for one or more categories of drugs other than alcohol and cannabis. Analyses also revealed that 5.6% of the trauma center and 9.0% of the medical examiner driver cases tested positive for two or more categories of drugs other than alcohol and cannabis.

Discussion

This study was the largest research effort to date in the United States to conduct independent toxicological analyses of blood specimens from roadway users who were seriously or fatally injured in motor vehicle crashes. The study extended beyond drivers to include pedestrians, bicyclists, passengers, and others (e.g., moped, ATV, and electric kick scooter riders) who were injured or killed in crashes with motor vehicles on roadways.

The report focused on drivers because of the large sample size available and the known potentially impairing effects of the studied drugs on motor vehicle operators. The overall drug positivity rate (including alcohol) of 54.4% for trauma center driver cases in this study is very similar to an ongoing study being conducted at emergency departments in Canada where 50.8% of drivers tested positive for one or more drugs through May 2021 when using a similar drug panel and data collection approach (Brubacher et al., 2021). While direct comparisons across these studies should be made with caution, the current study's trauma center driver cannabinoid (25.0%) and alcohol (21.6%) raw prevalence rates are higher than those reported in the Canadian study (18.8% and 15.5% respectively). The Canadian study reported higher positivity rates for opioids (11.0%) than the current study which found 8.6% opioid positivity for trauma center driver cases. Comparisons of the other drug categories across the two studies are limited because of the combinations of individual drugs that were included in the categories such as sedatives. Other factors limiting comparisons across the studies include toxicological testing methods and cutoffs utilized to define drug positivity. Regardless of their approach differences, the combined findings from these two studies suggest that seriously injured drivers in the United States and Canada are more likely than not to have alcohol or another potentially impairing drug in their system when the crash occurred.

The current study's findings do offer some suggestion that drug prevalence could be higher in the crashes where a driver is killed. Notably, 68.8% of the ME driver cases in this study's sample had one or more drugs on the study's toxicology panel detected in the driver's system. Of the total ME driver sample, 33.9% had two or more drug categories in their systems. While direct comparisons of the ME and trauma center driver case results should be made with caution, the differences in individual drug and two or more drug category prevalence rates observed offer some suggestion that certain drugs, or combinations of drugs, could potentially be associated with more severe crashes resulting in driver death.

This study also examined associations of drug positivity with driver age, sex, time of crash, and day of crash (weekday versus weekend). The findings suggest that within this sample of drivers, drug positivity rates had reliable associations with each of these factors. Males and females showed differences in positivity, with males more likely to be positive for some categories of drugs (i.e., alcohol, cannabinoids, stimulants) and females more likely to be positive for others (i.e., sedatives, antidepressants, OTC drugs). There were also a variety of differences in drug category positivity by age group that are potentially useful for informing targeted countermeasures depending on the intended audience.

The observed differences by time of day (increased overall drug positivity at night) and day of week (increased drug positivity on the weekend) are not surprising given similar results observed in past NHTSA roadside and crash risk studies referenced in the introduction of this report. Of interest, however, is that cannabinoids (active THC) positivity was still relatively high (over 20%) during the day and on weekdays, and sedative and opioid prevalence were actually higher

among both trauma center and ME driver cases during the day than at night. These findings are potentially useful because they underscore that drugs other than alcohol may play an important role in daytime traffic safety problems when alcohol use tends to be less prevalent.

While this report focused on presence/absence of drugs in a specimen, the quantification of drug concentrations has the potential to provide additional insights. A brief analysis of the alcohol concentration results found that 83.4% of the trauma center driver cases and 87.0% of the ME driver cases that were alcohol-positive had BACs at or above .08 g/dL, which is the illegal limit in all States except Utah where the limit is .05 g/dL. Concentration ranges were also examined for active THC and it was found that among those who tested positive, 80.0% of the trauma center driver cases and 86.4% of the ME driver cases had active THC concentrations at or above 2 ng/mL, which could be indicative of recent use, especially among occasional users. Given the average time from crash to blood draw in this study and what is known about the metabolism of cannabis, it is difficult to know with certainty when a THC-positive driver actually consumed the cannabis or the driver's blood concentration at the time of the crash. To address these uncertainties, more research is needed on the cannabis and driving topic to better understand how this drug could be affecting traffic safety given the prevalence levels observed here.

Overall, the results included in this report represent a first look at drug prevalence among a sample of seriously or fatally injured roadway users. Future research can analyze the data collected by this study to explore many more topics of interest. The study also sets an example by which future similar research can be conducted at other sites across the country. The participating Level 1 trauma centers and MEs were able to enact the study protocols without issue, even during the COVID-19 public health emergency. Future similar research at these sites or others across the country will be of particular use for monitoring changes in drugged driving over time, and will allow NHTSA and other traffic safety stakeholders to better tailor impaired driving countermeasures for particular regions or types of road users.

Limitations

This study selected seven sites that included high-volume trauma centers servicing large catchment areas, and was able to enlist MEs at four of those sites to assist the study. These sites were not a random sample of all Level 1 trauma centers across the country. As such, no inferences can be made regarding the applicability of the study findings beyond the populations served by these trauma centers and MEs. Because of the rolling start to data collection, inherent patient flow rate differences, and availability of staff during the public health emergency, some sites provided more specimens to the study than others. In addition, the onset of the COVID-19 public health emergency meant that some sites provided cases before the pandemic while others only provide cases during. These issues limit any comparisons across sites and certainly introduces some level of bias in the reported raw prevalence rates when data are combined across all sites for the entire study period. In addition, the ME results are biased toward fatalities in Maryland where the ME's office services the entire State. Because of this, 73.9% of all road user ME cases came from Maryland.

This study operated under the assumption that on-site research staff at the trauma centers and MEs checked the criteria for inclusion for each participant. Although strict criteria for inclusion were provided, it is possible that some cases did not meet the time from crash criterion due to a lack of information from EMS or unavailability of a crash report, especially during the COVID-19 public health emergency when access to patient care areas was greatly restricted for research of this type. The study did examine drug prevalence rates for included cases without a known time from crash to blood draw and found the prevalence patterns to be virtually identical to those when a time could be calculated. Still, future research will need to take this issue into consideration if similar restrictions on access to patient care areas remain in place.

As noted in the report, this study had to change its specimen collection and processing approach at the trauma centers during the public health emergency in order to provide viable specimens to NIH for COVID-19 antibody testing. The change involved first collecting specimens in a lavender-top tube and then splitting the sample into a gray-top for toxicological testing with the remainder in the lavender-top processed for plasma. In theory, the additional preservative found in the lavender-top tube could have affected the detection of drugs. Study staff closely monitored the patterns of results after the change in procedures and concluded the impact on study results was likely minimal if there was any impact at all. More laboratory research is needed to determine the degree to which such procedures could affect toxicological findings.

Overall, this study's results can only be used to describe the prevalence of drug positivity among the specific populations sampled and with full awareness of the study's design limitations. Without a matched control group or other basis for comparison to similar, non-injured, non-crash-involved roadway users, it is not possible to determine if any of the drugs studied here are associated with an increased risk of being seriously injured or killed in a motor vehicle crash. The study results should not be used to imply impairment or increased risk associated with drug presence.

References

Berning, A., Smith, R. C., Drexler, M., & Wochinger, K. (2022, March). *Drug testing and traffic safety: What you need to know* (Report No. DOT HS 813 264). National Highway Traffic Safety Administration. https://rosap.ntl.bts.gov/view/dot/60969

Berning, A., & Smither, D. D. (2014, November). *Understanding the limitations of drug test information, reporting, and testing practices in fatal crashes* (Traffic Safety Facts Research Note. DOT HS 812 072). National Highway Traffic Safety Administration. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812072

Blomberg, R. D., Peck, R. C., Moskowitz, H., Burns, M., & Fiorentino, D. (2009). The Long Beach/Fort Lauderdale relative risk study. *Journal of Safety Research*, *40*, 285-292.

Brubacher, J. R., Chan, H., Masud, M., Yuan, Y., Erdelyi, S., Likhodi, S., & the National Drug Driving Research Group (2021). *The 2021 National Drug Driving Study*. Department of Emergency Medicine, University of British Columbia.

Centers for Disease Control and Prevention. (2021). *Understanding the epidemic: The drug overdose epidemic continues to worsen in the United States* [Web page]. www.cdc.gov/drugoverdose/epidemic/index.htmL

Chang, M. C. (Ed.) (2016). *National Trauma Data Bank 2016 Annual Report*. American College of Surgeons.

Compton, R. P., & Berning, A. (2015, February). *Drug and alcohol crash risk* (Traffic Safety Facts Research Note. Report No. DOT HS 812 117). National Highway Traffic Safety Administration. www.nhtsa.gov/staticfiles/nti/pdf/812117-Drug_and_Alcohol_Crash_Risk.pdf

Czeisler, M. É., Lane, R. I., Petrosky, E., Wiley, J. F., Christensen, A., Njai, R., Weaver, M. D., Robbins, R., Facer-Childs, E. R., Barger, L. K., Czeisler, C. A., Howard, M. E., & Rajaratnam, S. (2020). Mental health, substance use, and suicidal ideation during the COVID-19 pandemic - United States, June 24-30, 2020. *Morbidity and Mortality Weekly Report, 69*(32), 1049–1057.

Grossman, E. R., Benjamin-Neelon, S. E., & Sonnenschein, S. (2020). Alcohol consumption during the COVID-19 pandemic: A cross-sectional survey of US adults. *International Journal of Environmental Research and Public Health, 17*(24), 9189. https://doi.org/10.3390/ijerph17249189

Hels, T., Bernhoft, I. M., Lyckegaard, A., Houwing, S., Hagenzieker, M., Legrand, S., & Verstraete, A. (2011). *Risk of injury by driving with alcohol and other drugs* (Project No. TREN-05-FP6TR-S07.61320-518404-DRUID). European Commission under the Transport RTD Programme of the 6th Framework Program. DRUID [Driving under the Influence of Drugs, Alcohol and Medicines]. https://orbit.dtu.dk/en/publications/risk-of-injury-by-driving-with-alcohol-and-other-drugs}

Kelley-Baker, T., Berning, A., Ramirez, A., Lacey, J. H., Carr, K., Waehrer, G., & Compton, R. (2017, May). *2013-2014 National Roadside Study of alcohol and drug use by drivers: Drug results* (Report No. DOT HS 812 411). National Highway Traffic Safety Administration. www.nhtsa.gov/sites/nhtsa.gov/files/documents/13013-nrs_drug-053117-v3-tag_0.pdf

Lacey, J. H., Kelley-Baker, T., Berning, A., Romano, E., Ramirez, A., Yao, J., Moore, C., Brainard, K., Carr, K., Pell, K., & Compton, R. (2016, December). *Drug and alcohol crash risk: A case-control study* (Report No. DOT HS 812 355). National Highway Traffic Safety Administration. https://rosap.ntl.bts.gov/view/dot/1973

Lacey, J. H., Kelley-Baker, T., Furr-Holden, C. D. M., Voas, R., Romano, E., Ramirez, A., Brainard, K., Moore, C., Torres, P., & Berning, A. (2009, December). *2007 National Roadside Survey of alcohol and drug use by drivers: Drug results* (Report No. DOT HS 811 249). National Highway Traffic Safety Administration. https://rosap.ntl.bts.gov/view/dot/1889

National Center for Health Statistics. (2021). *Health, United States, 2019: Table 39.* www.cdc.gov/nchs/hus/contents2019.htm

National Conference of State Legislatures. (2022, January 4). *State medical cannabis laws*. www.ncsl.org/research/health/state-medical-marijuana-laws.aspx

Ngo, T., Karkanitsa, M., Adusei, K., Graham, L., Ricotta, E., Darrah, J., Blomberg, R., Spathies, J., Pauly, K., Klumpp-Thomas, C., Travers, J., Mehalko, J., Drew, M., Hall, M., Memoli, M., Esposito, D., Kozar, R., Griggs, C., Cunningham, K., … & Sadtler, K. (in press). SARS-CoV-2 seroprevalence and drug use in trauma patients from six sites in the United States. National Institutes of Health. doi: 10.1101/2021.08.10.21261849

Office of Behavioral Safety Research. (2021a, January). *Update to special reports on traffic safety during the COVID-19 public health emergency: Third quarter data.* (Traffic Safety Facts Research Note. Report No. DOT HS 813 069). National Highway Traffic Safety Administration. https://rosap.ntl.bts.gov/view/dot/54290/dot_54290_DS1.pdf

Office of Behavioral Safety Research. (2021b, June). *Update to special reports on traffic safety during the COVID-19 public health emergency: Fourth quarter data* (Traffic Safety Facts Research Note. Report No. DOT HS 813 135). National Highway Traffic Safety Administration. www.nhtsa.gov/sites/nhtsa.gov/files/2021-06/Update_Traffic%20%1fSafety%20During%20COVID-19_4thQtr-060121-web.pdf

www.nhtsa.gov/sites/nhtsa.gov/files/2021-06/Update_Traffic%20Safety%20During%20COVID-19_4thQtr-060121-web.pdf

Ramirez, A., Berning, A., Carr, K., Scherer, M., Lacey, J. H., Kelley-Baker, T., & Fisher, D. A. (2016, July). *Marijuana, Other Drugs, and Alcohol Use by Drivers in Washington State* (Report No. DOT HS 812 299). National Highway Traffic Safety Administration. www.nhtsa.gov/sites/nhtsa.gov/files/812299-washingtonstatedrugstudy.pdf

Thomas, F. D., Berning, A., Darrah, J., Graham, L., Blomberg, R., Griggs, C., Crandall, M., Schulman, C., Kozar, R., Neavyn, M., Cunningham, K., Ehsani, J., Fell, J., Whitehill, J., Babu, K., Lai, J., & Rayner, M. (2020, October). *Drug and alcohol prevalence in seriously and fatally injured road users before and during the COVID-19 public health emergency* (Report No. DOT HS 813 018). National Highway Traffic Safety Administration. https://rosap.ntl.bts.gov/view/dot/50941/dot_50941_DS1.pdf

Wagner, E., Atkins, R., Berning, A., Robbins, A., Watson, C., & Anderle, J. (2020, October). *Examination of the traffic safety environment during the second quarter of 2020: Special report* (Traffic Safety Facts Research Note. Report No. DOT HS 813 011). National Highway Traffic Safety Administration. https://rosap.ntl.bts.gov/view/dot/50940

White House (2020, March 13). *Proclamation on Declaring a National Emergency Concerning the Novel Coronavirus Disease (COVID-19) Outbreak* (DCPD-202000156 - Proclamation 9994). Office of the Federal Register, National Archives and Records Administration. www.govinfo.gov/content/pkg/DCPD-202000156/pdf/DCPD-202000156.pdf

Appendix A: Additional Results

Table A-1.Trauma Center Cases: Drivers Positive for Drug Category by Vehicle Type

	Car (*n* =2,434)			SUV/Van (*n* =426)			Pickup truck (*n* =240)			Motorcycle (*n* =908)			All other (*n* =235)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	556	22.8	[21.2, 24.5]	67	15.7	[12.5, 19.4]	46	19.2	[14.6, 24.5]	201	22.1	[19.5, 24.9]	47	20.0	[15.3, 25.5]
Cannabinoids^	642	26.4	[24.7, 28.2]	74	17.4	[14.0, 21.2]	43	17.9	[13.5, 23.1]	249	27.4	[24.6, 30.4]	53	22.6	[17.6, 28.2]
Stimulants	238	9.8	[8.6, 11.0]	39	9.2	[6.7, 12.2]	24	10.0	[6.7, 14.3]	96	10.6	[8.7, 12.7]	20	8.5	[5.4, 12.6]
Sedatives	198	8.1	[7.1, 9.3]	35	8.2	[5.9, 11.1]	22	9.2	[6.0, 13.3]	52	5.7	[4.4, 7.4]	12	5.1	[2.8, 8.5]
Opioids	227	9.3	[8.2, 10.5]	46	10.8	[8.1, 14.0]	28	11.7	[8.1, 16.2]	42	4.6	[3.4, 6.1]	24	10.2	[6.8, 14.6]
Antidepressants	29	1.2	[0.8, 1.7]	9	2.1	[1.1, 3.8]	3	1.3	[0.4, 3.3]	6	0.7	[0.3, 1.4]	3	1.3	[0.4, 3.4]
Over-the-Counter	42	1.7	[1.3, 2.3]	5	1.2	[0.4, 2.6]	5	2.1	[0.8, 4.5]	4	0.4	[0.1, 1.0]	7	3.0	[1.3, 5.8]
Other Drugs	33	1.4	[1.0, 1.9]	1	0.2	[0.0, 1.1]	3	1.3	[0.4, 3.3]	21	2.3	[1.5, 3.4]	5	2.1	[0.8, 4.6]
Positive for Any Drug	1,369	56.2	[54.3, 58.2]	198	46.5	[41.8, 51.2]	130	54.2	[47.8, 60.4]	493	54.3	[51.0, 57.5]	117	49.8	[43.4, 56.1]
Drug Negative	1,065	43.8	[41.8, 45.7]	228	53.5	[48.8, 58.2]	110	45.8	[39.6, 52.2]	415	45.7	[42.5, 49.0]	118	50.2	[43.9, 58.6]
Positive for 2 or More Drug Categories	479	19.7	[18.1, 21.3]	63	14.8	[11.7, 18.4]	36	15.0	[10.9, 19.9]	147	16.2	[13.9, 18.7]	43	18.3	[13.8, 23.6]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-2. Medical Examiner Cases: Drivers Positive for Drug Category by Vehicle Type

	Car (*n* =256)			SUV/Van (*n* =76)			Pickup truck (*n* =52)			Motorcycle (*n* =123)			All other (*n* =48)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	112	43.8	[37.8, 49.9]	33	43.4	[32.7, 54.6]	18	34.6	[22.8, 48.1]	44	35.8	[27.7, 44.5]	9	18.8	[9.7, 31.4]
Cannabinoids^	86	33.6	[28.0, 39.5]	21	27.6	[18.5, 38.4]	20	38.5	[26.2, 52.0]	38	30.9	[23.2, 39.4]	11	22.9	[12.8, 36.2]
Stimulants	39	15.2	[11.2, 20.0]	9	11.8	[6.0, 20.5]	9	17.3	[8.9, 29.2]	7	5.7	[2.6, 10.8]	6	12.5	[5.4, 24.0]
Sedatives	17	6.6	[4.1, 10.2]	5	6.6	[2.6, 13.8]	3	5.8	[1.7, 14.6]	9	7.3	[3.7, 12.9]	6	12.5	[5.4, 24.0]
Opioids	32	12.5	[8.9, 17.0]	12	15.8	[8.9, 25.2]	8	15.4	[7.6, 26.9]	10	8.1	[4.3, 13.9]	10	20.8	[11.2, 33.8]
Antidepressants	2	0.8	[0.2, 2.5]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	1	0.8	[0.1, 3.7]	1	2.1	[0.2, 9.3]
Over-the-Counter	18	7.0	[4.4, 10.7]	0	0.0	[0.0, 0.0]	4	7.7	[2.7, 17.3]	0	0.0	[0.0, 0.0]	3	6.3	[1.8, 15.7]
Other Drugs	10	3.9	[2.0, 6.8]	6	7.9	[3.4, 15.5]	2	3.8	[0.8, 11.8]	4	3.3	[1.1, 7.5]	5	10.4	[4.1, 21.3]
Positive for Any Drug	189	73.8	[68.2, 78.9]	52	68.4	[57.4, 78.0]	36	69.2	[55.9, 80.5]	78	63.4	[54.7, 71.5]	27	56.3	[42.2, 69.6]
Drug Negative	67	26.2	[21.1, 31.8]	24	31.6	[22.0, 42.6]	16	30.8	[19.5, 44.1]	45	36.6	[28.5, 45.3]	21	43.8	[30.4, 57.8]
Positive for 2 or More Drug Categories	97	37.9	[32.1, 43.9]	26	34.2	[24.3, 45.3]	21	40.4	[27.9, 53.9]	28	22.8	[16.0, 30.8]	16	33.3	[21.3, 47.3]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-3. Jacksonville Trauma Center Cases Positive for Drug Category by Position in Crash

	Driver (*n* =703)			Passenger (*n* =171)			Bicyclist (*n* =23)			Pedestrian (*n* =65)			All Other (*n* =10)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	119	16.9	[14.3, 19.8]	18	10.5	[6.6, 15.8]	7	30.4	[14.8, 50.7]	19	29.2	[19.3, 41.0]	3	30.0	[9.3, 60.6]
Cannabinoids^	199	28.3	[25.1, 31.7]	45	26.3	[20.2, 33.3]	5	21.7	[8.8, 41.3]	14	21.5	[12.9, 32.6]	4	40.0	[15.3, 69.6]
Stimulants	65	9.2	[7.3, 11.6]	25	14.6	[9.9, 20.5]	2	8.7	[1.9, 25.1]	12	18.5	[10.5, 29.1]	3	30.0	[9.3, 60.6]
Sedatives	32	4.6	[3.2, 6.3]	15	8.8	[5.2, 13.7]	2	8.7	[1.9, 25.1]	5	7.7	[3.0, 16.0]	0	0.0	[0.0, 0.0]
Opioids	81	11.5	[9.3, 14.0]	21	12.3	[8.0, 17.8]	3	13.0	[3.8, 30.9]	3	4.6	[1.3, 11.8]	1	10.0	[1.1, 38.1]
Antidepressants	12	1.7	[0.9, 2.9]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	1	1.5	[0.2, 7.0]	0	0.0	[0.0, 0.0]
Over-the-Counter	16	2.3	[1.4, 3.6]	4	2.3	[0.8, 5.5]	1	4.3	[0.5, 18.6]	2	3.1	[0.6, 9.5]	0	0.0	[0.0, 0.0]
Other Drugs	3	0.4	[0.1, 1.1]	2	1.2	[0.2, 3.7]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Positive for Any Drug	392	55.8	[52.1, 59.4]	97	56.7	[49.2, 64.0]	13	56.5	[36.5, 75.0]	39	60.0	[47.9, 71.3]	8	80.0	[49.7, 95.6]
Drug Negative	311	44.2	[40.6, 47.9]	74	43.3	[36.0, 50.8]	10	43.5	[25.0, 63.5]	26	40.0	[28.7, 52.1]	2	20.0	[4.4, 50.3]
Positive for 2 or More Drug Categories	116	16.5	[13.9, 19.4]	22	12.9	[8.5, 18.5]	5	21.7	[8.8, 41.3]	15	23.1	[14.1, 34.3]	3	30.0	[9.3, 60.6]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-4. Jacksonville Medical Examiner Cases Positive for Drug Category by Position in Crash

	Driver (*n* =16)			Passenger (*n* =6)			Bicyclist (*n* =2)			Pedestrian (*n* =7)			All Other (*n* =8)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	7	43.8	[22.2, 67.4]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	4	57.1	[23.5, 86.1	2	25.0	[5.6, 59.2]
Cannabinoids^	8	50.0	[27.2, 72.8]	3	50.0	[16.7, 83.3]	2	100.0	[100.0, 100.0]	1	14.3	[1.6, 50.1]	2	25.0	[5.6, 59.2]
Stimulants	1	6.3	[0.7, 25.7]	1	16.7	[1.9, 55.8]	0	0.0	[0.0, 0.0]	1	14.3	[1.6, 50.1]	1	12.5	[1.4, 45.4]
Sedatives	1	6.3	[0.7, 25.7]	2	33.3	[7.7, 71.4]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Opioids	1	6.3	[0.7, 25.7]	1	16.7	[1.9, 55.8]	0	0.0	[0.0, 0.0]	1	14.3	[1.6, 50.1]	1	12.5	[1.4, 45.4]
Antidepressants	0	0.0	[0.0, 0.0]	1	16.7	[1.9, 55.8]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Over-the-Counter	0	0.0	[0.0, 0.0]	1	16.7	[1.9, 55.8]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Other Drugs	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Positive for Any Drug	11	68.8	[44.4, 86.9]	5	83.3	[44.2, 98.1]	2	100.0	[100.0, 100.0]	5	71.4	[35.2, 93.5]	4	50.0	[19.9, 80.1]
Drug Negative	5	31.2	[13.1, 55.6]	1	16.7	[1.9, 55.8]	0	0.0	[0.0, 0.0]	2	28.6	[6.5, 64.8]	4	50.0	[19.9, 80.1]
Positive for 2 or More Drug Categories	6	37.5	[17.4, 61.7]	3	50.0	[16.7, 83.3]	0	0.0	[0.0, 0.0]	2	28.6	[6.5, 64.8]	2	25.0	[5.6, 59.2]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-5. Charlotte Trauma Center Cases Positive for Drug Category by Position in Crash

	Driver (*n* =1,178)			Passenger (*n* =258)			Bicyclist (*n* =46)			Pedestrian (*n* =194)			All Other (*n* =34)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	290	24.6	[22.2, 27.1]	40	15.5	[11.5, 20.3]	7	15.2	[7.1, 27.6]	50	25.8	[20.0, 32.3]	12	35.3	[20.9, 52.0]
Cannabinoids^	277	23.5	[21.2, 26.0]	74	28.7	[23.4, 34.4]	6	13.0	[5.6, 24.9]	53	27.3	[21.4, 33.9]	5	14.7	[5.8, 29.3]
Stimulants	134	11.4	[9.7, 13.3]	28	10.9	[7.5, 15.1]	4	8.7	[3.0, 19.4]	29	14.9	[10.5, 20.5]	5	14.7	[5.8, 29.3]
Sedatives	106	9.0	[7.5, 10.7]	21	8.1	[5.3, 11.9]	1	2.2	[0.2, 9.7]	8	4.1	[2.0, 7.6]	3	8.8	[2.5, 21.7]
Opioids	81	6.9	[5.5, 8.4]	21	8.1	[5.3, 11.9]	2	4.3	[0.9, 13.2]	10	5.2	[2.7, 9.0]	0	0.0	[0.0, 0.0]
Antidepressants	20	1.7	[1.1, 2.6]	0	0.0	[0.0, 0.0]	1	2.2	[0.2, 9.7]	2	1.0	[0.2, 3.3]	1	2.9	[0.3, 12.9]
Over-the-Counter	18	1.5	[0.9, 2.4]	8	3.1	[1.5, 5.8]	1	2.2	[0.2, 9.7]	4	2.1	[0.7, 4.8]	0	0.0	[0.0, 0.0]
Other Drugs	19	1.6	[1.0, 2.5]	3	1.2	[0.3, 3.1]	0	0.0	[0.0, 0.0]	6	3.1	[1.3, 6.3]	0	0.0	[0.0, 0.0]
Positive for Any Drug	651	55.3	[52.4, 58.1]	131	50.8	[44.7, 56.8]	14	30.4	[18.6, 44.6]	107	55.2	[48.1, 62.0]	21	61.8	[45.0, 76.6]
Drug Negative	527	44.7	[41.9, 47.6]	127	49.2	[43.2, 55.3]	32	69.6	[55.4, 81.4]	87	44.8	[38.0, 51.9]	13	38.2	[23.4, 55.0]
Positive for 2 or More Drug	230	19.5	[17.3, 21.9]	51	19.8	[15.3, 24.9]	7	15.2	[7.1, 27.6]	41	21.1	[15.8, 27.3]	4	11.8	[4.1, 25.6]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-6. Charlotte Medical Examiner Cases Positive for Drug Category by Position in Crash

	Driver (*n* =67)			Passenger (*n* =8)			Bicyclist (*n* =3)			Pedestrian (*n* =24)			All Other (*n* =1)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	30	44.8	[33.3, 56.7]	3	37.5	[11.9, 70.5]	0	0.0	[0.0, 0.0]	10	41.7	[23.8, 61.4]	0	0.0	[0.0, 0.0]
Cannabinoids^	24	35.8	[25.1, 47.7]	4	50.0	[19.9, 80.1]	1	33.3	[3.9, 82.3]	4	16.7	[5.9, 34.9]	0	0.0	[0.0, 0.0]
Stimulants	6	9.0	[3.8, 17.5]	3	37.5	[11.9, 70.5]	1	33.3	[3.9, 82.3]	8	33.3	[17.2, 53.2]	0	0.0	[0.0, 0.0]
Sedatives	2	3.0	[0.6, 9.2]	1	12.5	[1.4, 45.4]	0	0.0	[0.0, 0.0]	2	8.3	[1.8, 24.1]	0	0.0	[0.0, 0.0]
Opioids	5	7.5	[2.9, 15.6]	1	12.5	[1.4, 45.4]	0	0.0	[0.0, 0.0]	4	16.7	[5.9, 34.9]	0	0.0	[0.0, 0.0]
Antidepressants	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Over-the-Counter	1	1.5	[0.2, 6.8]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Other Drugs	4	6.0	[2.0, 13.6]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Positive for Any Drug	47	70.1	[58.5, 80.1]	5	62.5	[29.5, 88.1]	2	66.7	[17.7, 96.1]	15	62.5	[42.6, 79.6]	0	0.0	[0.0, 0.0]
Drug Negative	20	29.9	[19.9, 41.5]	3	37.5	[11.9, 70.5]	1	33.3	[3.9, 82.3]	9	37.5	[20.4, 57.4]	1	100.0	[100.0, 100.0]
Positive for 2 or More Drug Categories	22	32.8	[22.5, 44.6]	4	50.0	[19.9, 80.1]	0	0.0	[0.0, 0.0]	10	41.7	[23.8, 61.4]	0	0.0	[0.0, 0.0]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-7. Miami Trauma Center Cases Positive for Drug Category by Position in Crash

	Driver (*n* =753)			Passenger (*n* =168)			Bicyclist (*n* =87)			Pedestrian (*n* =241)			All Other (*n* =47)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	173	23.0	[20.1, 26.1]	43	25.6	[19.5, 32.6]	18	20.7	[13.2, 30.1]	62	25.7	[20.5, 31.5]	11	23.4	[13.1, 36.8]
Cannabinoids^	198	26.3	[23.2, 29.5]	45	26.8	[20.5, 33.8]	14	16.1	[9.5, 24.9]	33	13.7	[0.0, 0.0]	7	14.9	[6.9, 27.0]
Stimulants	60	8.0	[6.2, 10.1]	18	10.7	[6.7, 16.1]	11	12.6	[6.9, 20.8]	21	8.7	[5.6, 12.8]	5	10.6	[4.2, 21.8]
Sedatives	57	7.6	[5.8, 9.6]	14	8.3	[4.9, 13.2]	3	3.4	[1.0, 8.9]	27	11.2	[7.7, 15.6]	4	8.5	[2.9, 19.0]
Opioids	40	5.3	[3.9, 7.1]	8	4.8	[2.3, 8.8]	5	5.7	[2.2, 12.1]	4	1.7	[0.6, 3.9]	2	4.3	[0.9, 13.0]
Antidepressants	2	0.3	[0.1, 0.8]	2	1.2	[0.2, 3.8]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Over-the-Counter	6	0.8	[0.3, 1.6]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	6	2.5	[1.0, 5.1]	0	0.0	[0.0, 0.0]
Other Drugs	5	0.7	[0.3, 1.4]	1	0.6	[0.1, 2.7]	1	1.1	[0.1, 5.8]	2	0.8	[0.2, 2.6]	0	0.0	[0.0, 0.0]
Positive for Any Drug	412	54.7	[51.1, 58.2]	95	56.5	[49.0, 63.9]	43	49.4	[39.1, 59.8]	119	49.4	[43.1, 55.7]	21	44.7	[31.1, 58.9]
Drug Negative	341	45.3	[41.8, 48.9]	73	43.5	[36.1, 51.0]	44	50.6	[40.2, 60.9]	122	50.6	[44.3, 56.9]	26	55.3	[41.1, 68.9]
Positive for 2 or More Drug Categories	103	13.7	[11.4, 16.3]	30	17.9	[12.6, 24.2]	9	10.3	[5.2, 18.0]	31	12.9	[9.1, 17.5]	8	17.0	[8.4, 29.6]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-8. Miami Medical Examiner Cases Positive for Drug Category by Position in Crash

	Driver (*n* =57)			Passenger (*n* =7)			Bicyclist (*n* =4)			Pedestrian (*n* =23)			All Other (*n* =1)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	23	40.4	[28.4, 53.3]	3	42.9	[13.9, 76.5]	0	0.0	[0.0, 0.0]	5	21.7	[8.8, 41.3]	0	0.0	[0.0, 0.0]
Cannabinoids^	16	28.1	[17.7, 40.6]	1	14.3	[1.6, 50.1]	2	50.0	[12.3, 87.7]	3	13.0	[3.8, 30.9]	0	0.0	[0.0, 0.0]
Stimulants	12	21.1	[12.1, 32.9]	2	28.6	[6.5, 64.8]	1	25.0	[2.8, 71.6]	3	13.0	[3.8, 30.9]	0	0.0	[0.0, 0.0]
Sedatives	8	14.0	[6.9, 24.7]	1	14.3	[1.6, 50.1]	0	0.0	[0.0, 0.0]	6	26.1	[11.7, 46.1]	0	0.0	[0.0, 0.0]
Opioids	5	8.8	[3.4, 18.2]	0	0.0	[0.0, 0.0]	1	25.0	[2.8, 71.6]	2	8.7	[1.9, 25.1]	1	100.0	[100.0, 100.0]
Antidepressants	1	1.8	[0.2, 7.9]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	1	4.3	[0.5, 18.6]	0	0.0	[0.0, 0.0]
Over-the-Counter	2	3.5	[0.7, 10.8]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	1	4.3	[0.5, 18.6]	0	0.0	[0.0, 0.0]
Other Drugs	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Positive for Any Drug	37	64.9	[52.0, 76.3]	5	71.4	[35.2, 93.5]	3	75.0	[28.4, 97.2]	13	56.5	[36.5, 75.0]	1	100.0	[100.0, 100.0]
Drug Negative	20	35.1	[23.7, 48.0]	2	28.6	[6.5, 64.8]	1	25.0	[2.8, 71.6]	10	43.5	[25.0, 63.5]	0	0.0	[0.0, 0.0]
Positive for 2 or More Drug Categories	21	36.8	[25.2, 49.8]	2	28.6	[6.5, 64.8]	1	25.0	[2.8, 71.6]	5	21.7	[8.8, 41.3]	0	0.0	[0.0, 0.0]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-9. Baltimore Trauma Center Cases Positive for Drug Category by Position in Crash

	Driver (*n* =730)			Passenger (*n* =163)			Bicyclist (*n* =33)			Pedestrian (*n* =155)			All Other (*n* =76)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	171	23.4	[20.5, 26.6]	33	20.2	[14.6, 26.9]	3	9.1	[2.6, 22.3]	35	22.6	[16.5, 29.6]	27	35.5	[25.5, 46.7]
Cannabinoids^	171	23.4	[20.5, 26.6]	47	28.8	[22.3, 36.1]	4	12.1	[4.2, 26.3]	38	24.5	[18.3, 31.7]	26	34.2	[24.3, 45.3]
Stimulants	54	7.4	[5.7, 9.5]	14	8.6	[5.0, 14.6]	0	0.0	[0.0, 0.0]	16	10.3	[6.3, 15.8]	4	5.3	[1.8, 12.0]
Sedatives	57	7.8	[6.0, 9.9]	13	8.0	[4.5, 12.9]	0	0.0	[0.0, 0.0]	14	9.0	[5.3, 14.3]	7	9.2	[4.2, 17.2]
Opioids	108	14.8	[12.4, 17.5]	27	16.6	[11.5, 22.8]	3	9.1	[2.6, 22.3]	32	20.6	[14.9, 27.5]	14	18.4	[11.0, 28.2]
Antidepressants	7	1.0	[0.4, 1.9]	0	0.0	[0.0, 0.0]	1	3.0	[0.3, 13.3]	0	0.0	[0.0, 0.0]	1	1.3	[0.1, 6.0]
Over-the-Counter	9	1.2	[0.6, 2.2]	3	1.8	[0.5, 4.8]	0	0.0	[0.0, 0.0]	4	2.6	[0.9, 6.0]	1	1.3	[0.1, 6.0]
Other Drugs	24	3.3	[2.2, 4.8]	3	1.8	[0.5, 4.8]	2	6.1	[1.3, 18.1]	5	3.2	[1.2, 6.9]	4	5.3	[1.8, 12.0]
Positive for Any Drug	405	55.5	[51.9, 59.1]	97	59.5	[51.9, 66.8]	11	33.3	[19.2, 50.3]	85	54.8	[47.0, 62.5]	54	71.1	[60.2, 80.3]
Drug Negative	325	44.5	[40.9, 48.1]	66	40.5	[33.2, 48.1]	22	66.7	[49.7, 80.8]	70	45.2	[37.5, 53.0]	22	28.9	[19.7, 39.8]
Positive for 2 or More Drug Categories	160	21.9	[19.0, 25.0]	35	21.5	[15.7, 28.2]	2	6.1	[1.3, 18.1]	41	26.5	[20.0, 33.8]	25	32.9	[23.1, 43.9]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-10. Baltimore Medical Examiner Cases Positive for Drug Category by Position in Crash

	Driver (*n* =415)			Passenger (*n* =74)			Bicyclist (*n* =14)			Pedestrian (*n* =153)			All Other (*n* =7)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	n	%	95% CI	*n*	%	95% CI
Alcohol	156	37.6	[33.0, 42.3]	19	25.7	[16.8, 36.4]	2	14.3	[3.1, 38.5]	55	35.9	[28.7, 43.8]	2	28.6	[6.5, 64.8]
Cannabinoids^	128	30.8	[26.5, 35.4]	19	25.7	[16.8, 36.4]	2	14.3	[3.1, 38.5]	28	18.3	[12.8, 25.0]	3	42.9	[13.9, 76.5]
Stimulants	51	12.3	[9.4, 15.7]	4	5.4	[1.9, 12.3]	1	7.1	[0.8, 28.8]	15	9.8	[5.8, 15.3]	1	14.3	[1.6, 50.1]
Sedatives	29	7.0	[4.8, 9.7]	4	5.4	[1.6, 12.3]	0	0.0	[0.0, 0.0]	17	11.1	[6.9, 16.8]	0	0.0	[0.0, 0.0]
Opioids	61	14.7	[11.5, 18.3]	11	14.9	[8.2, 24.2]	3	21.4	[6.4, 46.9]	39	25.5	[19.1, 32.8]	0	0.0	[0.0, 0.0]
Antidepressants	3	0.7	[0.2, 1.9]	1	1.4	[0.1, 6.1]	0	0.0	[0.0, 0.0]	3	2.0	[0.6, 5.1]	0	0.0	[0.0, 0.0]
Over-the-Counter	22	5.3	[3.4, 7.8]	2	2.7	[0.6, 8.4]	0	0.0	[0.0, 0.0]	10	6.5	[3.4, 11.3]	0	0.0	[0.0, 0.0]
Other Drugs	23	5.5	[3.6, 8.1]	2	2.7	[0.6, 8.4]	0	0.0	[0.0, 0.0]	7	4.6	[2.1, 8.8]	0	0.0	[0.0, 0.0]
Positive for Any Drug	287	69.2	[64.6, 73.5]	46	62.2	[50.8, 72.6]	6	42.9	[20.3, 68.1]	109	71.2	[63.7, 78.0]	4	57.1	[23.5, 86.1]
Drug Negative	128	30.8	[26.5, 35.4]	28	37.8	[27.4, 49.2]	8	57.1	[31.9, 79.7]	44	28.8	[22.0, 36.3]	3	42.9	[13.9, 76.5]
Positive for 2 or More Drug Categories	139	33.5	[29.1, 38.1]	12	16.2	[9.2, 25.8]	2	14.3	[3.1, 38.5]	53	34.6	[27.4, 42.4]	2	28.6	[6.5, 64.8]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-11. Worcester Trauma Center Cases Positive for Drug Category by Position in Crash

	Driver (*n* =291)			Passenger (*n* =42)			Bicyclist (*n* =12)			Pedestrian (*n* =56)			All Other (*n* =7)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	89	30.6	[25.5, 36.1]	12	28.6	[16.7, 43.3]	0	0.0	[0.0, 0.0]	17	30.4	[19.5, 43.2]	2	28.6	[6.5, 64.8]
Cannabinoids^	85	29.2	[24.2, 34.6]	12	28.6	[16.7, 43.3]	3	25.0	[7.6, 52.9]	15	26.8	[16.6, 39.3]	3	42.9	[13.9, 76.5]
Stimulants	23	7.9	[5.2, 11.4]	5	11.9	[4.7, 24.1]	0	0.0	[0.0, 0.0]	7	12.5	[5.8, 23.0]	0	0.0	[0.0, 0.0]
Sedatives	24	8.2	[5.5, 11.8]	0	0.0	[0.0, 0.0]	1	8.3	[0.9, 32.8]	11	19.6	[10.9, 31.4]	0	0.0	[0.0, 0.0]
Opioids	27	9.3	[6.3, 13.0]	3	7.1	[2.1, 17.9]	1	8.3	[0.9, 32.8]	4	7.1	[2.5, 16.1]	0	0.0	[0.0, 0.0]
Antidepressants	5	1.7	[0.7, 3.7]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	3	5.4	[1.5, 13.6]	0	0.0	[0.0, 0.0]
Over-the-Counter	1	0.3	[0.0, 1.6]	1	2.4	[0.3, 10.6]	0	0.0	[0.0, 0.0]	3	5.4	[1.5, 13.6]	0	0.0	[0.0, 0.0]
Other Drugs	5	1.7	[0.7, 3.7]	1	2.4	[0.3, 10.6]	0	0.0	[0.0, 0.0]	2	3.6	[0.7, 11.0]	0	0.0	[0.0, 0.0]
Positive for Any Drug	168	57.7	[52.0, 63.3]	21	50.0	[35.3, 64.7]	3	25.0	[7.6, 52.9]	41	73.2	[60.7, 83.4]	3	42.9	[13.9, 76.5]
Drug Negative	123	42.3	[36.7, 48.0]	21	50.0	[35.3, 64.7]	9	75.0	[47.1, 92.4]	15	26.8	[16.6, 39.3]	4	57.1	[23.5, 86.1]
Positive for 2 or More Drug Categories	73	25.1	[20.4, 30.3]	11	26.2	[14.8, 40.8]	1	8.3	[0.9, 32.8]	14	25.0	[15.1, 37.4]	2	28.6	[6.5, 64.8]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-12. Iowa Trauma Center Cases Positive for Drug Category by Position in Crash

	Driver (*n* =254)			Passenger (*n* =57)			Bicyclist (*n* =11)			Pedestrian (*n* =24)			All Other (*n* =4)		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	43	16.9	[12.7, 21.9]	11	19.3	[10.7, 30.9]	2	18.2	[4.0, 46.7]	6	25.0	[11.2, 44.5]	0	0.0	[0.0, 0.0]
Cannabinoids^	42	16.5	[12.4, 21.5]	14	24.6	[14.8, 36.8]	5	45.5	[20.0, 73.0]	5	20.8	[8.4, 39.8]	2	50.0	[12.3, 87.7]
Stimulants	30	11.8	[8.3, 16.2]	4	7.0	[2.4, 15.8]	0	0.0	[0.0, 0.0]	5	20.8	[8.4, 39.8]	0	0.0	[0.0, 0.0]
Sedatives	28	11.0	[7.6, 15.3]	1	1.8	[0.2, 7.9]	0	0.0	[0.0, 0.0]	1	4.2	[0.5, 17.9]	0	0.0	[0.0, 0.0]
Opioids	11	4.3	[2.3, 7.4]	2	3.5	[0.7, 10.8]	0	0.0	[0.0, 0.0]	1	4.2	[0.5, 17.9]	0	0.0	[0.0, 0.0]
Antidepressants	4	1.6	[0.5, 3.7]	1	1.8	[0.2, 7.9]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Over-the-Counter	8	3.1	[1.5, 5.9]	1	1.8	[0.2, 7.9]	0	0.0	[0.0, 0.0]	1	4.2	[0.5, 17.9]	0	0.0	[0.0, 0.0]
Other Drugs	7	2.8	[1.2, 5.3]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	1	4.2	[0.5, 17.9]	0	0.0	[0.0, 0.0]
Positive for Any Drug	115	45.3	[39.2, 51.4]	30	52.6	[39.8, 65.2]	5	45.5	[20.0, 73.0]	13	54.2	[34.7, 72.7]	2	50.0	[12.3, 87.7]
Drug Negative	139	54.7	[48.6, 60.8]	27	47.4	[34.8, 60.2]	6	54.5	[27.0, 80.0]	11	45.8	[27.3, 65.3]	2	50.0	[12.3, 87.7]
Positive for 2 or More Drug Categories	46	18.1	[13.7, 23.2]	4	7.0	[2.4, 15.8]	2	18.2	[4.0, 46.7]	6	25.0	[11.2, 44.5]	0	0.0	[0.0, 0.0]

^Active THC (Δ-9-THC or 11-OH-THC).
Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-13. Sacramento Trauma Center Cases Positive for Drug Category by Position in Crash

	Driver (*n* =334)			**Passenger (*n* =77)**			**Bicyclist (*n* =20)**			**Pedestrian (*n* =41)**			**All Other (*n* =17)**		
Drug Category	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI	*n*	%	95% CI
Alcohol	32	9.6	[6.8, 13.1]	3	3.9	[1.1, 10.0]	1	5.0	[0.5, 21.1]	3	7.3	[2.1, 18.3]	2	11.8	[2.5, 32.7]
Cannabinoids^	89	26.6	[22.1, 31.6]	18	23.4	[15.0, 33.7]	3	15.0	[4.4, 34.9]	9	22.0	[11.5, 36.2]	9	52.9	[30.3, 74.6]
Stimulants	51	15.3	[11.7, 19.4]	14	18.2	[10.8, 27.9]	9	45.0	[33.8, 74.9]	16	39.0	[25.3, 54.3]	1	5.9	[0.6, 24.4]
Sedatives	15	4.5	[2.6, 7.1]	2	2.6	[0.5, 8.1]	1	5.0	[0.5, 21.1]	0	0.0	[0.0, 0.0]	2	11.8	[2.5, 32.7]
Opioids	19	5.7	[3.6, 8.6]	5	6.5	[2.5, 13.6]	0	0.0	[0.0, 0.0]	2	4.9	[1.0, 14.7]	0	0.0	[0.0, 0.0]
Antidepressants	0	0.0	[0.0, 0.0]	1	1.3	[0.1, 5.9]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Over-the-Counter	5	1.5	[0.6, 3.2]	2	2.6	[0.5, 8.1]	1	5.0	[0.5, 21.1]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Other Drugs	0	0.0	[0.0, 0.0]	1	1.3	[0.1, 5.9]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]	0	0.0	[0.0, 0.0]
Positive for Any Drug	164	49.1	[43.8, 54.5]	35	45.5	[34.7, 56.6]	11	55.0	[33.8, 74.9]	20	48.8	[34.0, 63.7]	10	58.8	[35.6, 79.3]
Drug Negative	170	50.9	[45.5, 56.2]	42	54.5	[43.4, 65.3]	9	45.0	[25.1, 66.2]	21	51.2	[36.3, 66.0]	7	41.2	[20.7, 64.4]
Positive for 2 or More Drug Categories	40	12.0	[8.8, 15.8]	11	14.3	[7.8, 23.4]	3	15.0	[4.4, 34.9]	8	19.5	[9.7, 33.5]	4	23.5	[8.5, 46.7]

^Active THC (Δ-9-THC or 11-OH-THC).

Note: "Drug" refers to alcohol, medications, and all other drugs included on this study's toxicology panel.

Table A-14. Trauma Center Cases: All Road Users Positive for Parent Drugs or Metabolites

		n	**%**	**95% CI**
Alcohol	ethyl alcohol	1,364	21.4	[20.4, 22.4]
Cannabinoids	Δ-9-THC	1,560	24.4	[23.4, 25.5]
	11-OH-THC (hydroxy)	939	14.7	[13.9, 15.6]
	11-COOH-THC (carboxy)	2,087	32.7	[31.6, 33.9]
Stimulants	cocaine	235	3.7	[3.2, 4.3]
	Benzoylecgonine	593	9.3	[8.6, 10.0]
	cocaethylene	94	1.5	[1.2, 1.8]
	amphetamine	353	5.5	[5.0, 6.1]
	methamphetamine	331	5.2	[4.7, 5.8]
	MDMA	9	0.1	[0.1, 0.3]
	MDA	4	0.1	[0.0, 0.1]
	ephedrine	2	0.0	[0.0, 0.0]
	pseudoephedrine	2	0.0	[0.0, 0.0]
	phenylpropanolamine	0	0.0	[0.0, 0.0]
	phentermine	15	0.2	[0.1, 0.4]
	methylphenidate	2	0.0	[0.0, 0.1]
Sedatives	diazepam	70	1.1	[0.9, 1.4]
	nordiazepam	121	1.9	[1.6, 2.3]
	oxazepam	12	0.2	[0.1, 0.3]
	temazepam	26	0.4	[0.3, 0.6]
	clonazepam	58	0.9	[0.7, 1.2]
	7-aminoclonazepam	34	0.5	[0.4, 0.7]
	alprazolam	144	2.3	[1.9, 2.6]
	lorazepam	26	0.4	[0.3, 0.6]
	chlordiazepam	29	0.5	[0.3, 0.6]
	midazolam	69	1.1	[0.8, 1.4]
	bromazepam	12	0.2	[0.1, 0.3]
	butalbital	21	0.3	[0.2, 0.5]
	secobarbital	2	0.0	[0.0, 0.1]
	phenobarbital	3	0.0	[0.0, 0.1]
	carisoprodol	5	0.1	[0.0, 0.2]
	meprobamate	7	0.1	[0.0, 0.2]
	cyclobenzaprine	21	0.3	[0.2, 0.5]
	zolpidem	26	0.4	[0.3, 0.6]
Opioids	heroin (*6-monoacetylmorphine*)	2	0.0	[0.0, 0.1]
	morphine	44	0.7	[0.5, 0.9]

	codeine	7	0.1	[0.0, 0.2]
	hydrocodone	37	0.6	[0.4, 0.8]
	hydromorphone	9	0.1	[0.1, 0.3]
	oxycodone	82	1.3	[1.0, 1.6]
	oxymorphone	30	0.5	[0.3, 0.7]
	methadone	75	1.2	[0.9, 1.5]
	EDDP	38	0.6	[0.4, 0.8]
	buprenorphine	36	0.6	[0.4, 0.8]
	norbuprenorphine	45	0.7	[0.5, 0.9]
	fentanyl	279	4.4	[3.9, 4.9]
	norfentanyl	256	4.0	[3.6, 4.5]
	furanylfentanyl	5	0.1	[0.0, 0.2]
	acetylfentanyl	7	0.1	[0.0, 0.2]
	carfentanil	0	0.0	[0.0, 0.0]
	fluorofentanyl	4	0.1	[0.0, 0.1]
	tramadol	31	0.5	[0.3, 0.7]
Antidepressants	sertraline	13	0.2	[0.1, 0.3]
	fluoxetine	10	0.2	[0.1, 0.3]
	amitriptyline	20	0.3	[0.2, 0.5]
	nortriptyline	25	0.4	[0.3, 0.6]
	imipramine	0	0.0	[0.0, 0.0]
	desipramine	0	0.0	[0.0, 0.0]
	citalopram	7	0.1	[0.0, 0.2]
	doxepin	5	0.1	[0.0, 0.2]
	venlafaxine	3	0.0	[0.0, 0.1]
	trazadone	13	0.2	[0.1, 0.3]
Over-the-Counter	dextromethorphan	22	0.3	[0.2, 0.5]
	diphenhydramine	79	1.2	[1.0, 1.5]
	chlorpheniramine	4	0.1	[0.0, 0.1]
	doxylamine	5	0.1	[0.0, 0.2]
Other Drugs	phencyclidine	17	0.3	[0.2, 0.4]
	ketamine	81	1.3	[1.0, 1.6]
	alpha-PVP	0	0.0	[0.0, 0.0]

Table A-15. ME Cases: All Road Users Positive for Parent Drugs or Metabolites

		n	%	95% CI
Alcohol	ethyl alcohol	321	35.8	[32.7, 39.0]
Cannabinoids	Δ-9-THC	246	27.4	[24.6, 30.4]
	11-OH-THC (hydroxy)	142	15.8	[13.6, 18.3]
	11-COOH-THC (carboxy)	269	30.0	[27.1, 33.0]
Stimulants	cocaine	65	7.2	[5.7, 9.1]
	Benzoylecgonine	131	14.6	[12.4, 17.0]
	cocaethylene	32	3.6	[2.5, 4.9]
	amphetamine	40	4.5	[3.3, 6.0]
	methamphetamine	18	2.0	[1.2, 3.1]
	MDMA	6	0.7	[0.3, 1.4]
	MDA	1	0.1	[0.0, 0.5]
	ephedrine	1	0.1	[0.0, 0.5]
	pseudoephedrine	3	0.3	[0.1, 0.9]
	phenylpropanolamine	6	0.7	[0.3, 1.4]
	phentermine	2	0.2	[0.0, 0.7]
	methylphenidate	0	0.0	[0.0, 0.0]
Sedatives	diazepam	13	1.4	[0.8, 2.4]
	nordiazepam	20	2.2	[1.4, 3.4]
	oxazepam	2	0.2	[0.0, 0.7]
	temazepam	6	0.7	[0.3, 1.4]
	clonazepam	4	0.4	[0.2, 1.1]
	7-aminoclonazepam	5	0.6	[0.2, 1.2]
	alprazolam	19	2.1	[1.3, 3.2]
	lorazepam	8	0.9	[0.4, 1.7]
	chlordiazepam	4	0.4	[0.2, 1.1]
	midazolam	13	1.4	[0.8, 2.4]
	bromazepam	1	0.1	[0.0, 0.5]
	butalbital	1	0.1	[0.0, 0.5]
	secobarbital	0	0.0	[0.0, 0.0]
	phenobarbital	0	0.0	[0.0, 0.0]
	carisoprodol	1	0.1	[0.0, 0.5]
	meprobamate	1	0.1	[0.0, 0.5]
	cyclobenzaprine	4	0.4	[0.2, 1.1]
	zolpidem	1	0.1	[0.0, 0.5]
Opioids	heroin (*6-monoacetylmorphine*)	3	0.3	[0.1, 0.9]
	morphine	30	3.3	[2.3, 4.7]

	codeine	7	0.8	[0.3, 1.5]
	hydrocodone	0	0.0	[0.0, 0.0]
	hydromorphone	1	0.1	[0.0, 0.5]
	oxycodone	16	1.8	[1.1, 2.8]
	oxymorphone	8	0.9	[0.4, 1.7]
	methadone	25	2.8	[1.9, 4.0]
	EDDP	19	2.1	[1.3, 3.2]
	buprenorphine	16	1.8	[1.1, 2.8]
	norbuprenorphine	20	2.2	[1.4, 3.4]
	fentanyl	85	9.5	[7.7, 11.5]
	norfentanyl	74	8.2	[6.6, 10.2]
	furanylfentanyl	0	0.0	[0.0, 0.0]
	acetylfentanyl	8	0.9	[0.4, 1.7]
	carfentanil	0	0.0	[0.0, 0.0]
	fluorofentanyl	4	0.4	[0.2, 1.1]
	tramadol	11	1.2	[0.7, 2.1]
Antidepressants	sertraline	2	0.2	[0.0, 0.7]
	fluoxetine	0	0.0	[0.0, 0.0]
	amitriptyline	4	0.4	[0.2, 1.1]
	nortriptyline	5	0.6	[0.2, 1.2]
	imipramine	0	0.0	[0.0, 0.0]
	desipramine	0	0.0	[0.0, 0.0]
	citalopram	2	0.2	[0.0, 0.7]
	doxepin	0	0.0	[0.0, 0.0]
	venlafaxine	0	0.0	[0.0, 0.0]
	trazadone	5	0.4	[0.2, 1.2]
Over-the-Counter	dextromethorphan	9	1.0	[0.5, 1.8]
	diphenhydramine	32	3.6	[2.5, 4.9]
	chlorpheniramine	1	0.1	[0.0, 0.5]
	doxylamine	4	0.4	[0.2, 1.1]
Other Drugs	phencyclidine	19	2.1	[1.3, 3.2]
	ketamine	19	2.1	[1.3, 3.2]
	alpha-PVP	0	0.0	[0.0, 0.0]

Table A-16. Trauma Center Cases: Drivers Positive for Parent Drugs or Metabolites

		n	**%**	**95% CI**
Alcohol	ethyl alcohol	917	21.6	[20.4, 22.9]
Cannabinoids	Δ-9-THC	1,048	24.7	[23.4, 26.0]
	11-OH-THC (hydroxy)	643	15.2	[14.1, 16.3]
	11-COOH-THC (carboxy)	1,380	32.5	[31.1, 33.9]
Stimulants	cocaine	119	2.8	[2.3, 3.3]
	Benzoylecgonine	326	7.7	[6.9, 8.5]
	cocaethylene	48	1.2	[0.8, 1.5]
	amphetamine	232	5.5	[4.8, 6.2]
	methamphetamine	210	4.9	[4.3, 5.6]
	MDMA	6	0.1	[0.1, 0.3]
	MDA	1	0.0	[0.0, 0.1]
	ephedrine	2	0.0	[0.0, 0.2]
	pseudoephedrine	2	0.0	[0.0, 0.2]
	phenylpropanolamine	0	0.0	[0.0, 0.0]
	phentermine	15	0.4	[0.2, 0.6]
	methylphenidate	1	0.0	[0.0, 0.1]
Sedatives	diazepam	48	1.1	[0.8, 1.5]
	nordiazepam	79	1.9	[1.5, 2.3]
	oxazepam	4	0.1	[0.0, 0.2]
	temazepam	14	0.3	[0.2, 0.5]
	clonazepam	36	0.8	[0.6, 1.2]
	7-aminoclonazepam	21	0.5	[0.3, 0.7]
	alprazolam	99	2.3	[1.9, 2.8]
	lorazepam	20	0.5	[0.3, 0.7]
	chlordiazepam	13	0.3	[0.2, 0.5]
	midazolam	44	1.0	[0.8, 1.4]
	bromazepam	9	0.2	[0.1, 0.4]
	butalbital	16	0.4	[0.2, 0.6]
	secobarbital	2	0.0	[0.0, 0.2]
	phenobarbital	2	0.0	[0.0, 0.2]
	carisoprodol	4	0.1	[0.0, 0.2]
	meprobamate	5	0.1	[0.0, 0.3]
	cyclobenzaprine	18	0.4	[0.3, 0.7]
	zolpidem	21	0.5	[0.3, 0.7]
Opioids	heroin (*6-monoacetylmorphine*)	1	0.0	[0.0, 0.1]
	morphine	26	0.6	[0.4, 0.9]

	codeine	4	0.1	[0.0, 0.2]
	hydrocodone	30	0.7	[0.5, 1.0]
	hydromorphone	7	0.2	[0.1, 0.3]
	oxycodone	67	1.6	[1.2, 2.0]
	oxymorphone	23	0.5	[0.4, 0.8]
	methadone	45	1.1	[0.8, 1.4]
	EDDP	22	0.5	[0.3, 0.8]
	buprenorphine	25	0.6	[0.4, 0.9]
	norbuprenorphine	32	0.8	[0.5, 1.0]
	fentanyl	179	4.2	[3.6, 4.9]
	norfentanyl	162	3.8	[3.3, 4.4]
	furanylfentanyl	4	0.1	[0.0, 0.2]
	acetylfentanyl	5	0.1	[0.0, 0.3]
	carfentanil	0	0.0	[0.0, 0.0]
	fluorofentanyl	3	0.1	[0.0, 0.2]
	tramadol	23	0.5	[0.4, 0.8]
Antidepressants	sertraline	10	0.2	[0.1, 0.4]
	fluoxetine	8	0.2	[0.1, 0.4]
	amitriptyline	16	0.4	[0.3, 0.6]
	nortriptyline	21	0.5	[0.3, 0.7]
	imipramine	0	0.0	[0.0, 0.0]
	desipramine	0	0.0	[0.0, 0.0]
	citalopram	5	0.1	[0.0, 0.3]
	doxepin	4	0.1	[0.0, 0.2]
	venlafaxine	2	0.0	[0.0, 0.2]
	trazadone	11	0.3	[0.1, 0.4]
Over-the-Counter	dextromethorphan	15	0.4	[0.2, 0.6]
	diphenhydramine	45	1.1	[0.8, 1.4]
	chlorpheniramine	3	0.1	[0.0, 0.2]
	doxylamine	4	0.1	[0.0, 0.2]
Other Drugs	phencyclidine	12	0.3	[0.2, 0.5]
	ketamine	52	1.2	[0.9, 1.6]
	alpha-PVP	0	0.0	[0.0, 0.0]

Table A-17. ME Cases: Drivers Positive for Parent Drugs or Metabolites

		n	**%**	**95% CI**
Alcohol	ethyl alcohol	216	38.9	[34.9, 43.0]
Cannabinoids	Δ-9-THC	171	30.8	[27.1, 34.7]
	11-OH-THC (hydroxy)	99	17.8	[14.8, 21.2]
	11-COOH-THC (carboxy)	182	32.8	[29.0, 36.8]
Stimulants	cocaine	42	7.6	[5.6, 10.0]
	Benzoylecgonine	81	14.6	[11.8, 17.7]
	cocaethylene	24	4.3	[2.9, 6.3]
	amphetamine	22	4.0	[2.6, 5.8]
	methamphetamine	12	2.2	[1.2, 3.6]
	MDMA	5	0.9	[0.3, 2.0]
	MDA	1	0.2	[0.2, 0.8]
	ephedrine	1	0.2	[0.0, 0.8]
	pseudoephedrine	2	0.4	[0.1, 1.2]
	phenylpropanolamine	3	0.5	[0.2, 1.4]
	phentermine	0	0.0	[0.0, 0.0]
	methylphenidate	0	0.0	[0.0, 0.0]
Sedatives	diazepam	8	1.4	[0.7, 2.7]
	nordiazepam	9	1.6	[0.8, 2.9]
	oxazepam	0	0.0	[0.0, 0.0]
	temazepam	3	0.5	[0.2, 1.4]
	clonazepam	3	0.5	[0.2, 1.4]
	7-aminoclonazepam	2	0.4	[0.1, 1.2]
	alprazolam	13	2.3	[1.3, 3.9]
	lorazepam	3	0.5	[0.2, 1.4]
	chlordiazepam	0	0.0	[0.0, 0.0]
	midazolam	8	1.4	[0.7, 2.7]
	bromazepam	0	0.0	[0.0, 0.0]
	butalbital	1	0.2	[0.0, 0.8]
	secobarbital	0	0.0	[0.0, 0.0]
	phenobarbital	0	0.0	[0.0, 0.0]
	carisoprodol	1	0.2	[0.0, 0.8]
	meprobamate	1	0.2	[0.0, 0.8]
	cyclobenzaprine	1	0.2	[0.0, 0.8]
	zolpidem	1	0.2	[0.0, 0.8]
Opioids	heroin (*6-monoacetylmorphine*)	0	0.0	[0.0, 0.0]
	morphine	16	2.9	[1.7, 4.5]

	codeine	4	0.7	[0.2, 1.7]
	hydrocodone	0	0.0	[0.0, 0.0]
	hydromorphone	0	0.0	[0.0, 0.0]
	oxycodone	9	1.6	[0.8, 2.9]
	oxymorphone	5	0.9	[0.3, 2.0]
	methadone	14	2.5	[1.5, 4.1]
	EDDP	9	1.6	[0.8, 2.9]
	buprenorphine	12	2.2	[1.2, 3.6]
	norbuprenorphine	14	2.5	[1.5, 4.1]
	fentanyl	42	7.6	[5.6, 10.0]
	norfentanyl	35	6.3	[4.5, 8.6]
	furanylfentanyl	0	0.0	[0.0, 0.0]
	acetylfentanyl	3	0.5	[0.2, 1.4]
	carfentanil	0	0.0	[0.0, 0.0]
	fluorofentanyl	2	0.4	[0.1, 1.2]
	tramadol	3	0.5	[0.2, 1.4]
Antidepressants	sertraline	0	0.0	[0.0, 0.0]
	fluoxetine	0	0.0	[0.0, 0.0]
	amitriptyline	3	0.5	[0.2, 1.4]
	nortriptyline	3	0.5	[0.2, 1.4]
	imipramine	0	0.0	[0.0, 0.0]
	desipramine	0	0.0	[0.0, 0.0]
	citalopram	1	0.2	[0.0, 0.8]
	doxepin	0	0.0	[0.0, 0.0]
	venlafaxine	0	0.0	[0.0, 0.0]
	trazadone	1	0.2	[0.0, 0.8]
Over-the-Counter	dextromethorphan	7	1.3	[0.6, 2.5]
	diphenhydramine	20	3.6	[2.3, 5.4]
	chlorpheniramine	1	0.2	[0.0, 0.8]
	doxylamine	4	0.7	[0.2, 1.7]
Other Drugs	phencyclidine	13	2.3	[1.3, 3.9]
	ketamine	15	2.7	[1.6, 4.3]
	alpha-PVP	0	0.0	[0.0, 0.0]

Appendix B: Drug Screening and Confirmation Thresholds

Drugs/*Metabolites*: Grouped by Screening Package	**Minimum Blood Concentration Detection Thresholds (ng/mL)**	
	ELISA Screen	**LC-MS/MS Confirm**
cocaine, *benzoylecgonine, cocaethylene*	25	10
6-AM, codeine, morphine, hydrocodone, hydromorphone	25	10
amphetamine, methamphetamine, MDMA, MDA, ephedrine, pseudoephedrine, phenylpropanolamine	20	10
Δ-9-THC, *11-OH-THC, 11-COOH-THC*	5	1
phencyclidine	10	10
buprenorphine, *norbuprenorphine*	1	1
alprazolam, chlordiazepoxide, oxazepam, nordiazepam, lorazepam, diazepam, clonazepam, *7-aminoclonazepam*, temazepam, bromazepam, midazolam, flualprazolam, etizolam	20	10
phenobarbital, secobarbital, butalbital	100	100
methadone, *EDDP*	50	10
diphenhydramine, doxylamine, chlorpheniramine	25	10
fentanyl, *norfentanyl*, furanyl fentanyl, carfentanil, fluorofentanyl	1	0.5
oxycodone; oxymorphone	25	10
tramadol	50	10
carisoprodol; meprobamate	500	500
sertraline	50	10
fluoxetine	50	10
amitryptiline, nortriptyline, doxepin, imipramine, desipramine, citalopram, venlafaxine, trazadone, cyclobenzaprine	25	10
zolpidem	10	10
dextromethorphan	50	20
ketamine	10	10
α-pyrrolidinopentiophenone	5	1
ethyl alcohol	20 mg/dL	20 mg/dL

Notes: Drugs and metabolites are grouped together if a single screen could be used. Alcohol testing used an enzyme-based screen and HS-GC-FID for confirmation.

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