Preliminary Analysis of DUI Crashes, Stops, and Sentencing Patterns in Franklin County, Pennsylvania

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Prepared exclusively for the Franklin/Fulton Drug and Alcohol Administration.

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ABOUT THE LEHIGH VALLEY JUSTICE INSTITUTE

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1. **Research** - Utilizing academic resources, LVJI provides a solid empirical, data-driven approach to assessing the current deficiencies and inequities inherent in criminal justice processes.
2. **Policy Development** - Building upon solid data analysis, modeling, and research of innovative and best practices nationwide, LVJI develops policy and procedural recommendations for the management of local governmental systems.
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ABOUT THE RESEARCHERS

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Timothy Loftus is a Data Analyst Research Intern. He is from Natick, Massachusetts, and is currently pursuing a B.S. in computer science from the University of Rochester while minoring in political science and Spanish. His work at LVJI started in September of 2023 and involves researching complex data and drawing conclusions to aid local governments and organizations. He is motivated by the intersection of computing and government, particularly criminal justice and rehabilitation.

Pranav Mishra is a Data Analyst Research Intern and a junior majoring in mathematics and computer science at Dickinson College. As an international student from India, he is passionate about using data analytics to make a positive impact on his community in the socioeconomic and medical sectors. His current research centers around uncovering insights from socioeconomic and biomedical data across multiple projects.

Raegan Brinkman is a Data Analyst Research Intern. She is pursuing a B.S. in Mathematical Sciences with a concentration in Operations Research and Statistics from Carnegie Mellon University in Pittsburgh, PA. Raegan began working with LVJI in September of 2023, using criminal justice data to derive county comparisons within Pennsylvania. She is inspired by the ever-growing trend of using data analysis to make policy decisions and further criminal justice reforms.

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EXECUTIVE SUMMARY

Research Objectives

Driving under the influence (DUI) is a serious and complex public health issue that afflicts every state and county in the United States. Still, each region has its own unique challenges and population. Addressing this phenomenon requires insight into a region's current situation involving DUI crashes, treatment, arrests and sentencing, and recidivism, an understanding how that fits into a broader context.

We strove to provide a comprehensive and in-depth overview of driving under the influence in Franklin County, Pennsylvania. Our goal was to strengthen Franklin County agencies' knowledge of DUIs in their county to help direct, inform, and refine prevention and rehabilitation efforts. To that end, we set out to identify:

- The vulnerable population or populations which to target reform efforts
- The substances used and their relative frequencies
- The consequences of DUI, whether crash, stop, arrest, conviction, and sentencing
- The factors that contribute to recidivism
- How Franklin County compares to Pennsylvania and other counties
- Potential areas for future research

Methodology

We studied four facets of DUI to provide a robust understanding of this phenomenon.

- Crashes
- Traffic stops
- Sentencing and recidivism
- County comparisons

We used three primary datasets for our research. For information on vehicle crashes, we used a dataset from the Pennsylvania Department of Transportation, which contained information on drugged or drunk drivers involved. We used data on traffic stops from the Pennsylvania State Police that contained information on location, date, time, and cause for the stop, among other details. We used sentencing datasets from the Pennsylvania Commission on Sentencing which contained information on cases sentenced in Pennsylvania from 2017 to 2021 and allowed us to filter out DUI cases to examine recidivism and treatment of DUI offenders.

Analysis was completed using various data and geospatial analysis software. Statistical tests and models were used where appropriate.

Results and Implications

Our analysis found significant variation in DUI crashes year-by-year. We also found that DUI-related crashes spiked in 2020, possibly due to mental health issues caused by the COVID-19 pandemic. DUI crashes also occurred most frequently in densely populated areas and clustered around alcohol outlets in Chambersburg and Waynesboro. Young male drivers were most likely to be involved in DUI crashes, and crashes involving drug use were more likely to result in injuries or fatalities.

Alcohol was involved in most DUI traffic stops. However, a significant number of stops found drivers with blood alcohol content well below the legal limit, and many below 0.02.

DUI sentencing trends in Franklin County revealed that a large percentage of DUIs are from repeat offenders, suggesting that curbing recidivism may be crucial to preventing DUIs. Franklin County also sentenced young people to DUIs at a rate that is higher than that of the rest of Pennsylvania. Young people were also more likely to commit higher-tiered DUIs and DUIs involving controlled substances.

Comparisons of Franklin County directly to other counties revealed that the county did not have particularly high or low DUI rate and was not anomalous in terms of DUI tiers and crashes. However, it did show that Franklin County had the second-highest rate of DUI involvement from young people relative to other counties in Pennsylvania.

Our goal with this research was to provide information that can help policymakers in Franklin County target and prevent DUIs using a bolstered understanding of the current DUI situation in the county. We also aimed to recommend data-supported actions the county can take to address this matter.

We recommend that Franklin County address prevention efforts towards young men, and particularly towards DUIs involving alcohol and controlled substances other than marijuana. We also recommend that the county prioritize curbing DUI recidivism by prioritizing treatment in combination with other forms of non-carceral treatment to repeat offenders who often suffer from mental health and alcohol use disorders. Generally, we recommend that the county concentrate on prevention efforts alternative to incarceration given its high cost and limited effectiveness in preventing recidivism. Our analysis includes preliminary evaluations on the effectiveness of several existing DUI prevention methods. We hope that our analysis and research will provide information and recommendations that will help Franklin make efficient and substantial strides towards improving the DUI situation in the county.

DATA AND METHOD

We used three main datasets described in detail below and cited in the References section. When additional data was needed to enhance an analysis, like demographic information, the supplementary data is described in that particular research question.

Crash data

Crash data across all of Pennsylvania was obtained from the Pennsylvania Department of Transportation (PennDOT). PennDOT compiles raw information about any crash that is reportable into CSVs accessible to the public. By Title 75, Section 3746(a) of Pennsylvania Consolidated Statutes, this includes crashes that involve injury or death to any involved person or damage to any vehicle such that it can no longer be driven safely and requires towing. PennDOT disclaims that this dataset does not include non-reportable crashes or near misses, and that some records may be incomplete.

We accessed a total of ten databases, one for each year from 2013 to 2022. Within each yearly database, there were multiple tables that contained detailed information regarding each crash, including a crash ID number (CRN) that was used to link records associated with the same incident. The tables that we utilized in our research were:

1. CRASH – this table contained general information pertaining to each crash – including as a variety of incident information including but not limited to the time of day, the location, and the number of injuries and fatalities.

2. FLAG – this table contained information that allowed us to identify which crashes involved drivers under the influence of substances. It included several self-explanatory indicator variables, such as:

    a. DRINKING_DRIVER
    b. DRUGGED_DRIVER
    c. MARIJUANA_DRUGGED_DRIVER
    d. INJURY_OR_FATALITY
    e. CHILD_PASSENGER

    These variables allowed us to not only filter out DUIs, but also filter out specific information pertaining to DUIs, which enhanced our understanding of DUIs in Franklin County.

3. PERSON – this table contained information for each person involved in every crash documented in the dataset, including drivers, passengers, and pedestrians. It allowed us to investigate this phenomenon among different age groups, sexes, and other demographic groups. Specifically, we made use of the columns:

    a. AGE
    b. SEX
    c. PERSON_TYPE

Traffic stop data

We received a compact disc containing data on traffic stops and arrests in Pennsylvania via a Right to Know request from the Pennsylvania State Police (PSP). Data originated from two main sources: Computed-Aided Dispatch (CAD) and CDR (Contact Data Reporting) reports. When an officer in a vehicle initiates a traffic stop, they call the dispatcher (Law Enforcement Information Technology Standards Council, 2009). The CAD datasets contained information on all these stops between January 1, 2020, and September 30, 2023. PSP Troopers are required to electronically complete a Contact Data Report for every member-initiated traffic stop regardless of the stop's outcome (Engel et al., 2023). We received CDR data from January 1, 2023, through December 11, 2023. CAD data included the location coordinates of the stop when it was called into a dispatcher, the date and time of the call, and the initial and final call types. PSP had also delivered a subset of these stops coded as DUIs. CDR data also contained location, date, and time figures in addition to detailed information about the driver, the reason for the stop, and the outcome of the stop including searches, seizures, violations, and if an arrest was made.

Matching the CAD data with the CDR data was difficult for four reasons. First, neither dataset contained an ID number with which to match the records. Second, the location and time of the CAD record and its corresponding CDR record were different because the call and CDR report were recorded at different times, with the call happening before the stop and the CDR being completed after the interaction. This also meant that the precise geographic coordinates were slightly different as well. Third, both datasets spanned different time periods, and as such most of the CAD records could not have matching CDR records. Finally, it is possible that some CAD stops did not have a matching CDR record because the survey was not filled out, and some CDR records did not have a matching CAD record because the traffic stop was not called into the dispatch (Engel et al., 2023).

We matched CDR records with CAD records that had the same date and were within 0.5 miles of each other. This resulted in 2,110 CDR records being matched to 54,146 CAD records in Franklin County. Because of this low match rate, we decided to use the CAD dataset for a precise measure of the number of stops and supplement it with information from the CDR records instead of relying on the matching.

Sentencing and recidivism data

The sentencing datasets used for this study are from the Pennsylvania Commission on Sentencing. The datasets include detailed information on each case sentenced in Pennsylvania during each year from January 1 to December 31 for the years 2017 to 2021.

Some key fields that were used were (Pennsylvania Commission on Sentencing, 2019):

- CID: Commission ID number, representing the unique commission ID for each case
- DOFAGE: Offender age at date of offense (years)
- DUILABEL: Shortened description for DUIs
- INCTYPE: Type of incarceration (state vs county)
- INCMAX: Maximum of sentenced incarceration time (months)
- ofn_label: Offense description from the Pennsylvania Criminal Code
- RIP_TYPE1, RIP_TYPE2, 3, 4, 5: Types of restrictive intermediate punishment component of county intermediate punishment for first RIP entered; RIP is referred to as "restrictive probation conditions" for this study

Because cases often had multiple convictions, to find DUI cases we filtered cases that contained at least one charge involving a DUI. We determined this using the DUILABEL and ofn_label fields.[1] From DUILABEL and ofn_label, we created DUI_TIER and NUM_OFFENSE. DUI_TIER indicated the tier of the DUI offense (either 1, 2, 3, as defined by the Pennsylvania Criminal Code); NUM_OFFENSE identified whether the current DUI charge was the offender's first, second, third, or fourth/subsequent DUI offense. Since fourth/subsequent offenses were uncommon, for certain analyses we combined those cases to look at third/subsequent offenses. A very small number of DUI offenses did not have information on the tier of offense or the number of prior offenses. For research involving tier of number of prior offenses, we excluded cases that did not have this information. We do not believe this significantly impacted the results; in Franklin County, throughout all five years of data, only eight offenses did not list the number of prior offenses and 26 did not have a tier.

It is important to note that these datasets concern all cases *sentenced* from 2017 to 2021 and do not concern all cases that *occurred* within those years. In these datasets, all cases involving DUIs occurred between 1997 to 2021, but an overwhelming majority (98.2%) occurred between 2015 and 2021. Figure *i* shows the distribution of offense years of all DUI cases sentenced in Pennsylvania between 2017 and 2021.

Further, due to Clean Slate laws, these data do not represent all DUIs that occurred in Pennsylvania. Clean Slate law automatically shields from public view any records of second and third degree misdemeanors if the person has remained crime-free for at least 10 years (Administrative Office of Pennsylvania Courts, n.d.). Several DUI offenses, most regarding first or second offenses, qualify for Clean Slate shielding. As such, these datasets likely omit many of these offenses or cases.

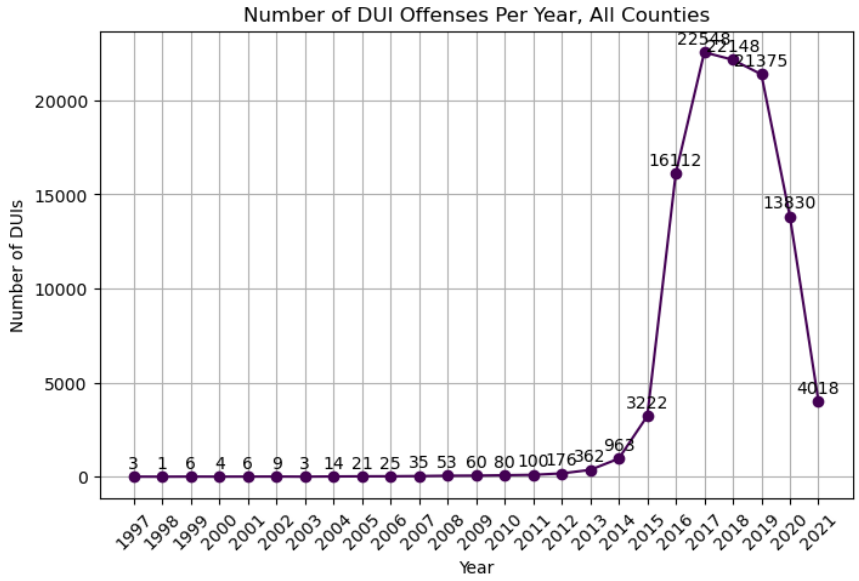


Figure i: *Some DUIs occurred nearly 30 years ago, but the vast majority occurred between 2015 and 2021.*

[1] Most DUI charges had a tier listed in the DUILABEL field, but some did not when the DUI involved controlled substances, general impairment, or a DUI charge that the law considered more serious than the actual DUI, such as fleeing an officer or homicide by DUI.

Software and General Methodology

Analysis was completed using Python, R, and ArcGIS Pro. A complete list of software and packages is available in the References section.

Statistical tests rely on the assumption that the studied dataset is a random sample of the population. Because our analyses dealt mostly with population data, this meant that statistical tests were often not applicable. However, we took some modeling opportunities defining the population as future crashes, and the datasets we have as a sample.

PART I: DUI CRASHES

Research Questions

1a. What proportion of crashes were substance-related, and what were the trends from the last decade?

1b. Were DUI crashes more prevalent around stores selling alcohol for on-site consumption and/or medical marijuana dispensaries?

1c. What times of day were DUI crashes most prevalent?

1d. What was the variability of substances that were involved in DUI crashes, and what are the trends from the last decade?

1e. What were the demographics of individuals involved in crashes and in DUI crashes? What were the trends from the last decade?

1f. Did substance usage in DUI crashes differ between age groups or gender?

1g. Were DUI crashes more likely to involve serious injury or death than non-DUI crashes?

1h. What other driving hazards or consequences correlated with substance use in crashes?

Primary Findings

- DUI crashes did not always follow the same trends as non-DUI crashes, suggesting that there are different aggravating factors for each type of crash. They may follow a cyclic pattern.
- The COVID-19 pandemic likely spurred an increase of DUI crashes in 2021 due to mental health issues exacerbating DUI behavior. This suggests that mental health treatment options may prevent DUI behavior that leads to crashes.
- DUI crashes clustered in Chambersburg, Waynesboro, and Greencastle. DUI crashes clustered more in populous areas than the highways.
- DUI crashes were more frequent on road segments that were closer to alcohol outlets, but only in Chambersburg and Waynesboro. As these regions have the highest alcohol outlet concentrations in the county, it is possible that excessive alcohol consumption may be encouraged there.
- Substance involvement, age involvement, and gender involvement in DUI crashes varied strongly by year. This suggests the existence of DUI substance and behavior trends.
- For every female involved in a DUI crash, there were three males involved in similar incidents. In other words, men were three times as likely to be involved in a DUI crash as compared to women.

- Crashes involving drivers aged 16 to 20 were more likely to have involved marijuana than crashes involving other age groups.
- Drivers aged 34 and under were the most likely to be involved in DUI crashes.
- Crashes with at least one driver under the influence of alcohol were 37% more likely to have injury or fatality. Crashes with at least one driver under the influence of drugs were 71% more likely to have injury or fatality.
- Risky behaviors like not wearing a seatbelt and speeding were more prevalent in DUI crashes than non-DUI crashes.

Methodology and Data

We used the crash data from 2013 to 2022 to answer these research questions. For geospatial mapping and analysis, crashes that did not list a latitude or longitude or were outside Franklin County were dropped from the dataset. Up-to-date shapefiles for local roads, state roads, and traffic volumes on road segments were obtained from PennDOT's Open Data Portal. Data regarding the current liquor licenses was obtained from the Pennsylvania Liquor Control Board. The board maintains a database of current and former liquor licenses of all kinds. Licenses for alcohol sales not intended to be consumed on-site were removed.

Results

1a. What proportion of crashes were substance-related, and what were the trends from the last decade?

Overall trend

There were 14,683 vehicular accidents in Franklin County between 2013 and 2022; 11% (1,626) involved DUI. Figure 1.1 shows the number of crashes and the proportions that involved substances in each year.

Figure 1.1 reveals that there was not an obvious overall trend in DUI crashes in Franklin County in the last decade. DUI crashes were increasing between 2013 and 2017 before decreasing in 2018. They reached their peak in 2021 at 189 crashes but returned to 2013 levels in 2022 (148 crashes). Importantly, Figure 1.1 demonstrates that DUI crashes do not always follow the same trend as non-DUI crashes, suggesting that there are different aggravating factors for each type of crash, as we discuss in the other Research Questions in Part I.

The 2021 spike in DUI crashes likely resulted from the COVID-19 pandemic. In 2020, lockdowns reduced traffic (South, 2020), which led to a dramatic decline in non-DUI crashes but a less dramatic decline in DUI crashes.[2] When the lockdowns were lifted in 2021 (Husch Blackwell, 2021), DUI crashes increased to the highest number in the decade. This suggests that the pandemic exacerbated substance misuse and DUI

[2] Franklin County saw a steeper decline in non-DUI crashes (19%) compared to DUI crashes (4%) during 2019-2020, suggesting that DUI behavior may have been aggravated.

behavior. The pandemic has been associated with increased alcohol consumption, likely from people who are "drinking to cope" (Barbosa et al., 2021). One Australian research team investigating the effects of the pandemic on drink-driving reported that DUI activity during the pandemic was predicted by previous engagement, and that these drivers' behaviors were not significantly affected by the shutdowns (Watson-Brown et al., 2021). They also found that a small percentage of surveyed individuals reported an intention to drink and drive while not reporting any prior engagement in that behavior (Watson-Brown et al., 2021). Consequently, alcohol consumption and DUI behavior may be exacerbated by mental distress such as worrying about health or finances (Manning et al., 2021) or from greater degrees of risk acceptance (Gong, Lu, & Yang, 2023). Understanding these DUI risk factors, as illuminated by the pandemic, can help officials prepare prevention materials or procedures for possible similar future events.

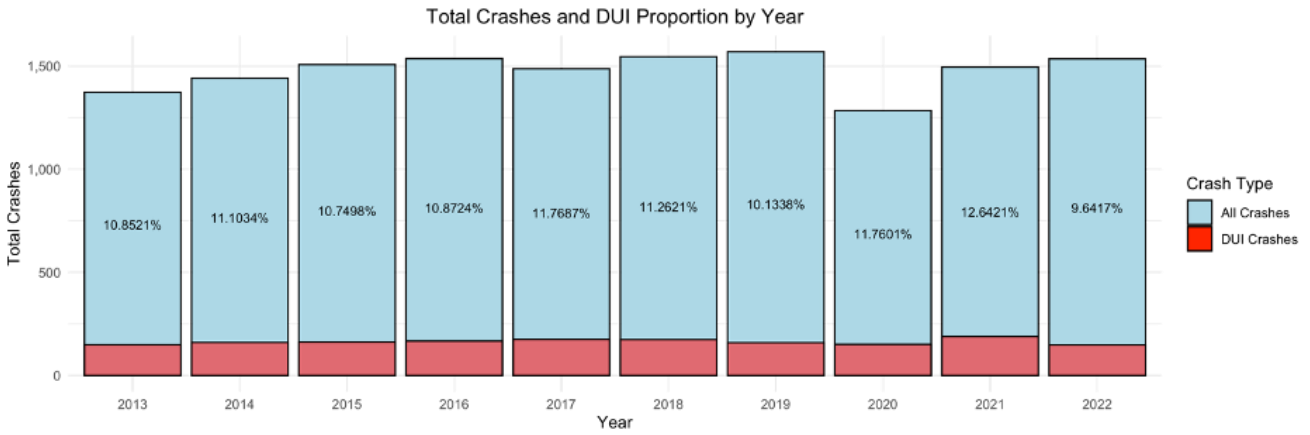


***Figure 1.1**: The COVID-19 pandemic decreased the total number of crashes in Franklin County in 2020, but the number of DUI crashes remained largely consistent from 2013 to 2022.*

Spatial trends

We inquired whether there have been notable spatial trends in DUI crashes in Franklin County. Doing so is vital to determine whether historical events may have spurred increases or decreases in their frequency, so officials can be mindful of events that may trigger similar fluctuations in DUI behavior and crashes. In Figure 1.2, we first investigated where DUI crashes occurred over the last decade. Aligned with prior research, DUI crashes clustered in cities (Alam & Tabassum, 2023); mainly, Chambersburg, Waynesboro, and Greencastle. There were also some denser portions of DUI crashes along the major highways.

Next, we examined if there were any spatial trends in DUI crash incidents using an established technique called Emerging Hot Spot Analysis (Alam & Tabassum, 2023). This tool divides the study area into a hexagonal grid and identifies trends in incident data through space and time. Broadly, it identifies areas where incidents are increasing, diminishing, or sporadic over time.[3] We defined each area as a hexagon that is 0.5 miles in height. We set the time intervals to 1 month, meaning that the tool checks for statistically significant increases or decreases of incident counts in each hexagon within periods of 1 month. Simultaneously, we performed this analysis for DUI crashes and for all crashes in Franklin County to see if there were areas where DUI crashes were increasing or decreasing in frequency.

[3] For more information on Emerging Hot Spot Analysis works, see ESRI (n.d.).

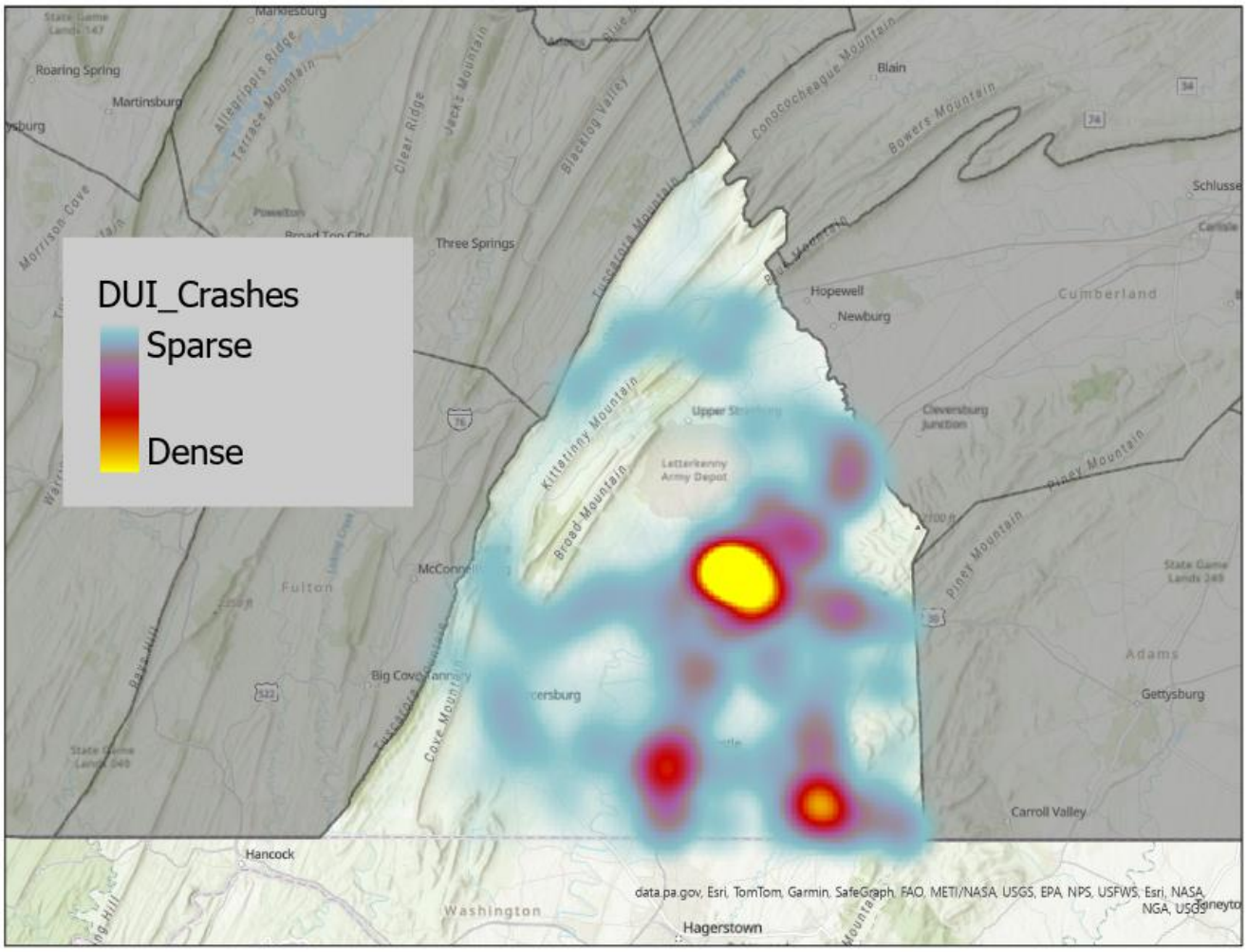


Figure 1.2: *DUI crashes clustered in Chambersburg, Waynesboro, and Greencastle.*

Figures 1.3 and 1.4 map the results of the Emerging Hot Spot Analysis for DUI crashes and all crashes in Franklin County, respectively. According to ESRI, there are 17 possible hot spot outcomes for each hexagon (ESRI, n.d.), but these results only produce two. Figure 1.3 reveals sporadic hot spots near Chambersburg and Greencastle, but everywhere else experienced no detectable pattern across time. This implies that there were "flare-ups" of DUI crashes in the two towns, but otherwise trends were stable for the past 10 years. This agrees with our assessment in Figure 1.1 that DUI crashes may follow a cyclic pattern. Because of these results, we were confident to move forward with spatial analyses that did not involve a time component.

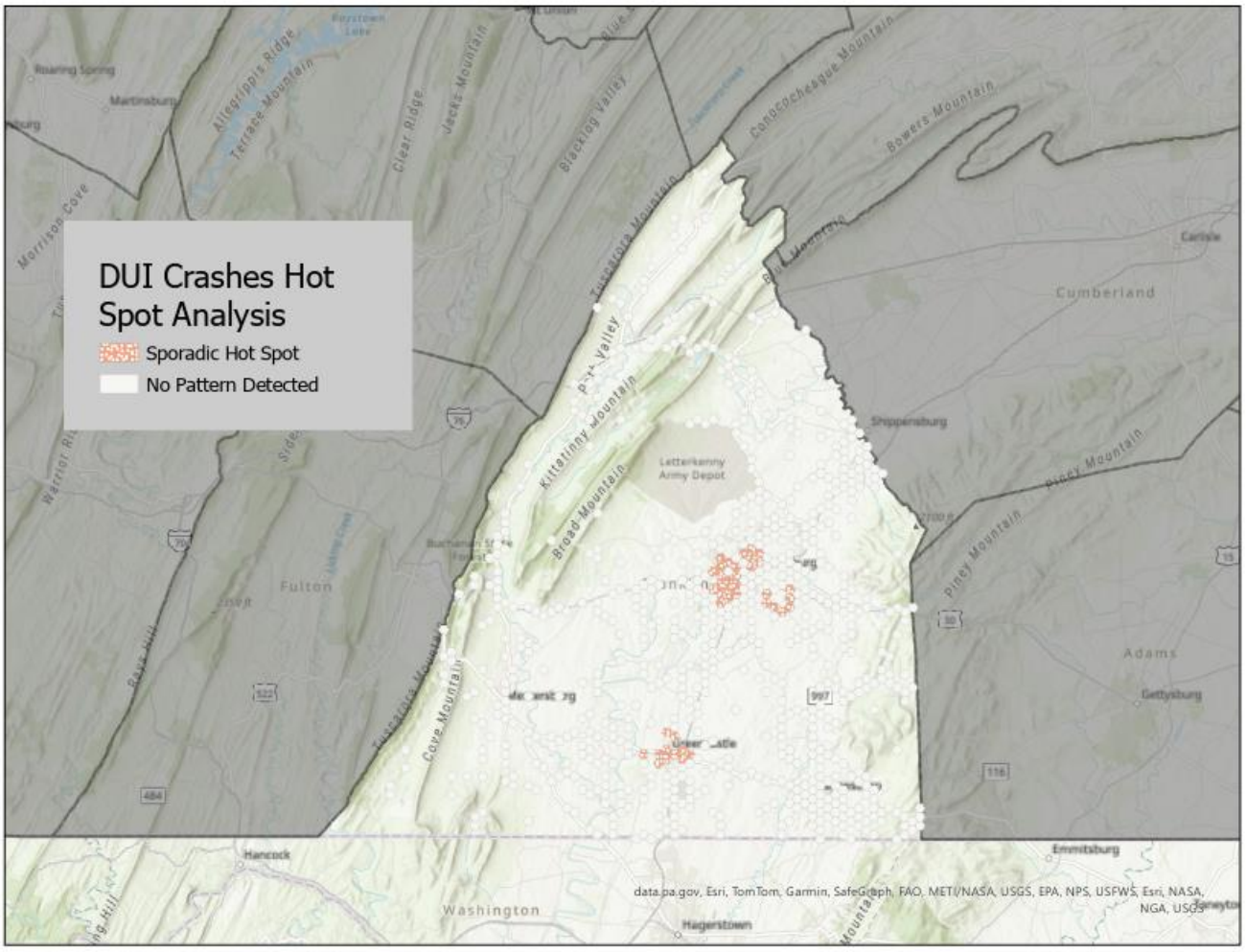


***Figure 1.3**: Emerging Hot Spot Analysis revealed that DUI crashes in Franklin County remained stable throughout the last decade, with some sporadic hot spots in Chambersburg and Greencastle.*

The map of all crashes in Figure 1.4 is more interesting than that of just DUI crashes. In addition to the sporadic hot spots in the Chambersburg area, there were also intensifying hot spots and some persistent hot spots in that area as well as in the Waynesboro area. Intensifying hot spots are regions that were significant hot spots for at least 90% of the examined months, and the incident counts had a significantly increasing trend over the entire period (ESRI, n.d.). Persistent hot spots are the same, but without any observable trend (ESRI, n.d.). This tells us that crashes in center Chambersburg were very often prevalent, and they are increasing in frequency. Furthermore, the stretch of I81 just south of its junction with Route 30 was a persistent hot spot for crashes, as shown in the zoomed-in map of Chambersburg in Figure 1.5.

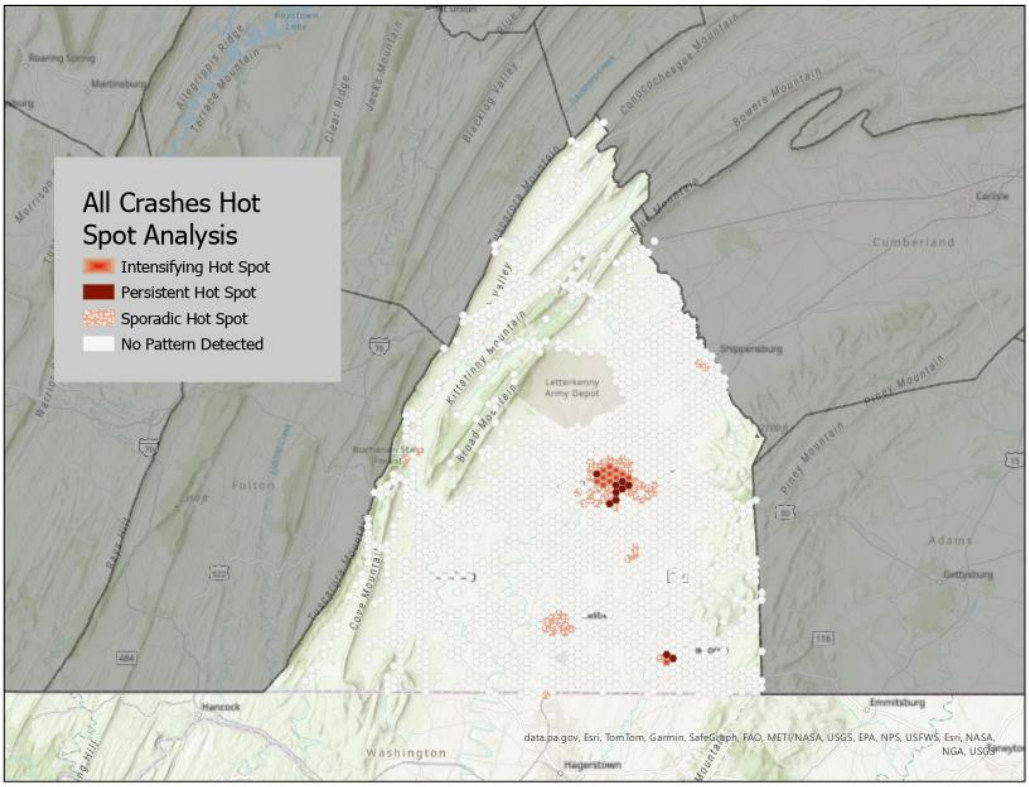


***Figure 1.4**: Chambersburg and Waynesboro had persistent and intensifying hot spots, indicating the areas where crashes of all types are most common and increasing.*

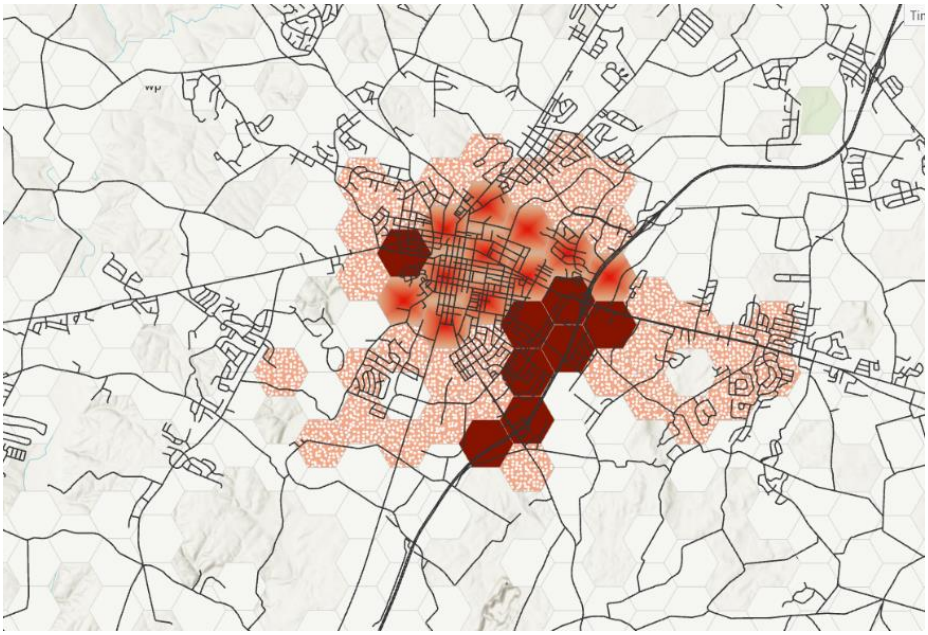


***Figure 1.5**: Accidents were increasing in incidence in center Chambersburg; the segment of I81 south of Route 30 was a persistent hot spot for all types of accidents.*

1b. Were DUI crashes more prevalent around stores selling alcohol for on-site consumption and/or medical marijuana dispensaries?

Spatial relationship between alcohol outlets and DUI crashes

We were interested in examining trends in the location of DUI crashes surrounding restaurants, bars, or other locations selling alcohol for on-site consumption to investigate if individuals who drink in social settings are prone to driving and engaging in accidents. This can help us understand the drinking patterns and behaviors of individuals in Franklin County, which can inform prevention and treatment efforts.

Figure 1.6 maps Franklin County locations with a liquor license to sell alcohol for on-site consumption. Locations are differentiated by the type of licensure. Note that special occasion permits are brief licenses that are active for a few weeks at a time. Expectedly, alcohol outlets clustered around the crash hot spot locations, in Chambersburg, Mercersburg, Greencastle, and Waynesboro. Because of this, and because prior research found that DUI crashes occur more frequently in more densely populated and retailer-dense areas (Levine, 2017; Wang et al., 2020), we can expect DUI crashes to be spatially correlated with these clusters of alcohol outlets.

To assess if the distance to the nearest alcohol outlet significantly affected the frequency of DUI crashes on road segments, we used a Generalized Poisson Regression (GPR) and a Geographically Weighted Poisson Regression (GWPR). GPR models the number of DUI crashes on a road segment given a set of control variables, and it assumes that the effect of distance is equal across the entire county. GWPR does not make this assumption; it evaluates the relationship between distance and DUI crashes for each predefined neighborhood. We utilized both models to investigate which performs better, using Akaike Information Criterion (AIC), Mean Absolute Deviation (MAD), and Mean Squared Prediction Error (MSPE) (Li et al., 2013). Each model had the same predictors: the number of total crashes on a segment, a segment's distance to the nearest alcohol outlet in feet, and the annual average daily traffic (AADT) on a segment.

With ArcGIS Pro, we determined how many crashes and how many DUI crashes were within 20 feet of each road segment to obtain frequencies of crashes on each segment. Then, we calculated the straight-line distance between each segment's center and the nearest alcohol outlet in feet. AADT was provided by PennDOT's Traffic Volumes dataset. It represents the average number of vehicles passing through that segment each day. Table 1.1 contains a summary of the variables.

Variable	Mean	Standard Deviation	Min	Max
DUI Crashes	0.631	1.937	0	25
Total Crashes	6.623	19.610	0	374
Distance	8,987.885	9,030.160	15.467	79,077.344
AADT	972.841	2,605.406	1	24,222
Total road segments	3,111			

***Table 1.1**: Descriptive statistics for the set of road segments used in the regression models.*

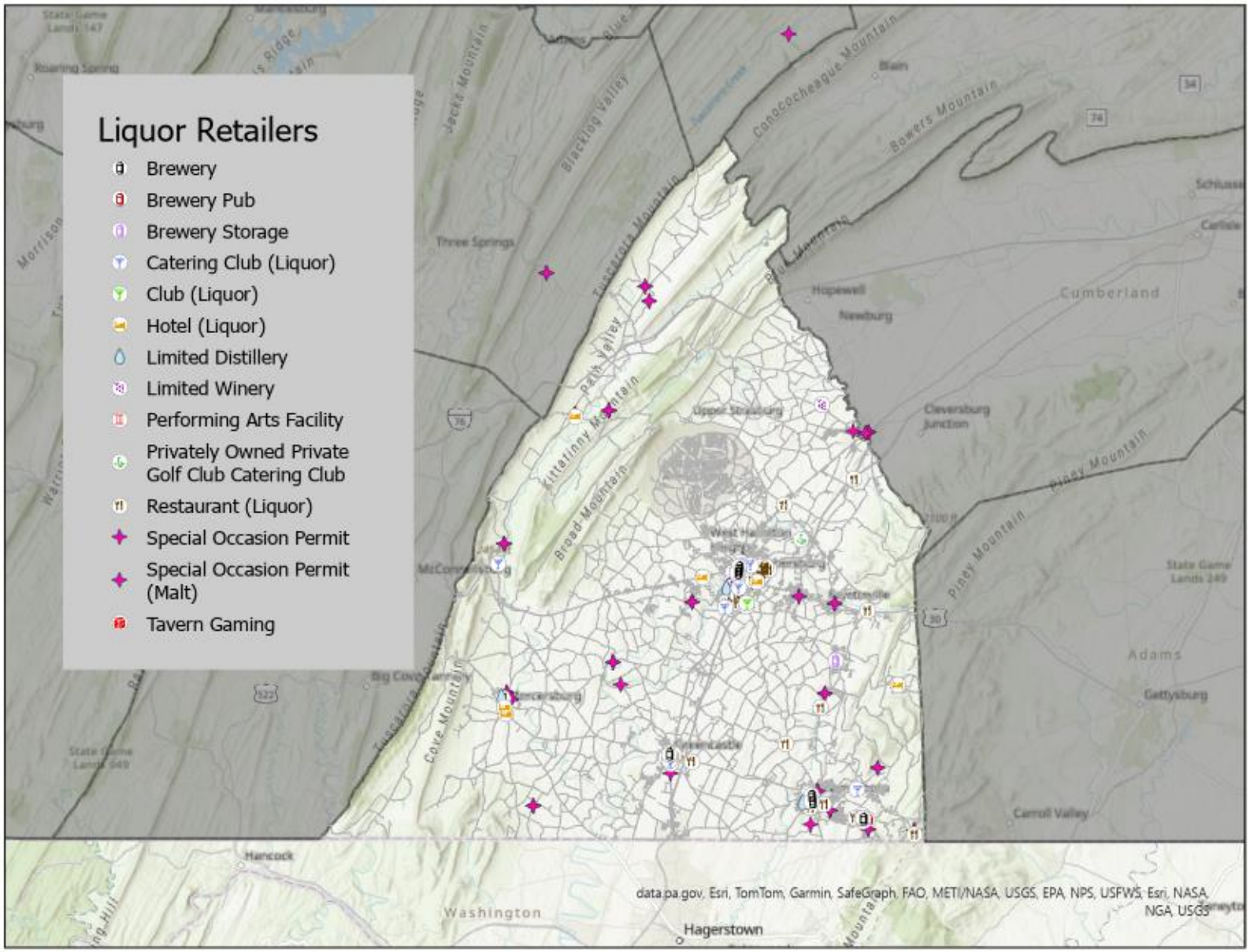


***Figure 1.6**: Alcohol outlets are clustered in town centers.*

The results from the GPR are displayed in Table 1.2. The GPR reported significant coefficients for all variables. Most importantly, the distance to the nearest alcohol outlet was significant. The coefficient is negative, which means that the relationship between distance and the number of DUI crashes is negative – when the distance to the nearest alcohol outlet increases by 1000 feet, the expected number of DUI crashes on that segment decreases by a factor of $e\left(-\frac{0.032}{1000}\right) = 0.969$, or 3.1%. The GPR model concluded that globally, in all of Franklin County, DUI crashes were more prevalent in areas closer to alcohol outlets.

Variable	**Coefficient**	**Standard Error**	**t-Statistic**	***p*-value**	
Total Crashes	0.011535	0.000286	40.309438	<0.001	
Distance	-0.000032	0.000003	-9.307079	<0.001	
AADT	0.000099	0.000004	25.50292	<0.001	
Intercept	-0.69655	0.036809	-18.92334	<0.001	
Goodness-of-Fit Measures					
AIC	*6517.2324*	*MAD*	*0.5689*	*MSPE*	*6.3979*

***Table 1.2**: The results of the GPR model show that each variable significantly predicted the count of DUI crashes on a road segment.*

It is possible that the relationship between distance and DUI crashes varied throughout Franklin County rather than being fixed. The GWPR model accounts for this; the results are in Table 1.3, which presents the five-number summaries of the coefficients. Each of the three goodness-of-fit measures was smaller than those of the GPR model, indicating that the GWPR model fits the data better.

The smallest coefficient for distance was -0.000241, which means that the strongest negative relationship detected was that for every 1000-feet increase in distance to alcohol outlets, the expected count of DUI crashes decreased by 21.3%. The maximum coefficient for distance was positive, indicating that in at least one neighborhood an increase of 1000 feet increased the expected DUI crash count by 2.7%.

Variable	**Minimum**	**1st Quartile**	**Median**	**3rd Quartile**	**Maximum**
Total crashes	0.008515	0.010002	0.011352	0.024367	0.148062
Distance	-0.000241	-0.000113	-0.000053	-0.000013	0.000027
AADT	-0.00147	0.000063	0.000091	0.000101	0.007367
Intercept	-1.771895	-1.009652	-0.645101	-0.493102	0.408978
Goodness-of-Fit Measures					
AIC	*4168.6423*	*MAD*	*0.5599*	*MSPE*	*3.2568*

***Table 1.3**: The results from the GWPR model indicate that the effect of distance on DUI crashes varies throughout the county.*

However, not all reported coefficients were statistically significant. Figure 1.7 maps the road segments in green that had a statistically significant relationship with the distance to the nearest alcohol outlet. The areas surrounding the greater Chambersburg and Waynesboro regions had significant relationships with

distance. This implies that in these areas, the farther away a segment was from an alcohol outlet, the fewer DUI crashes it had. In the Mercersburg, Greencastle, and Upper Strasburg regions, there was no evidence that the number of DUI crashes was related to the distance to an alcohol outlet.

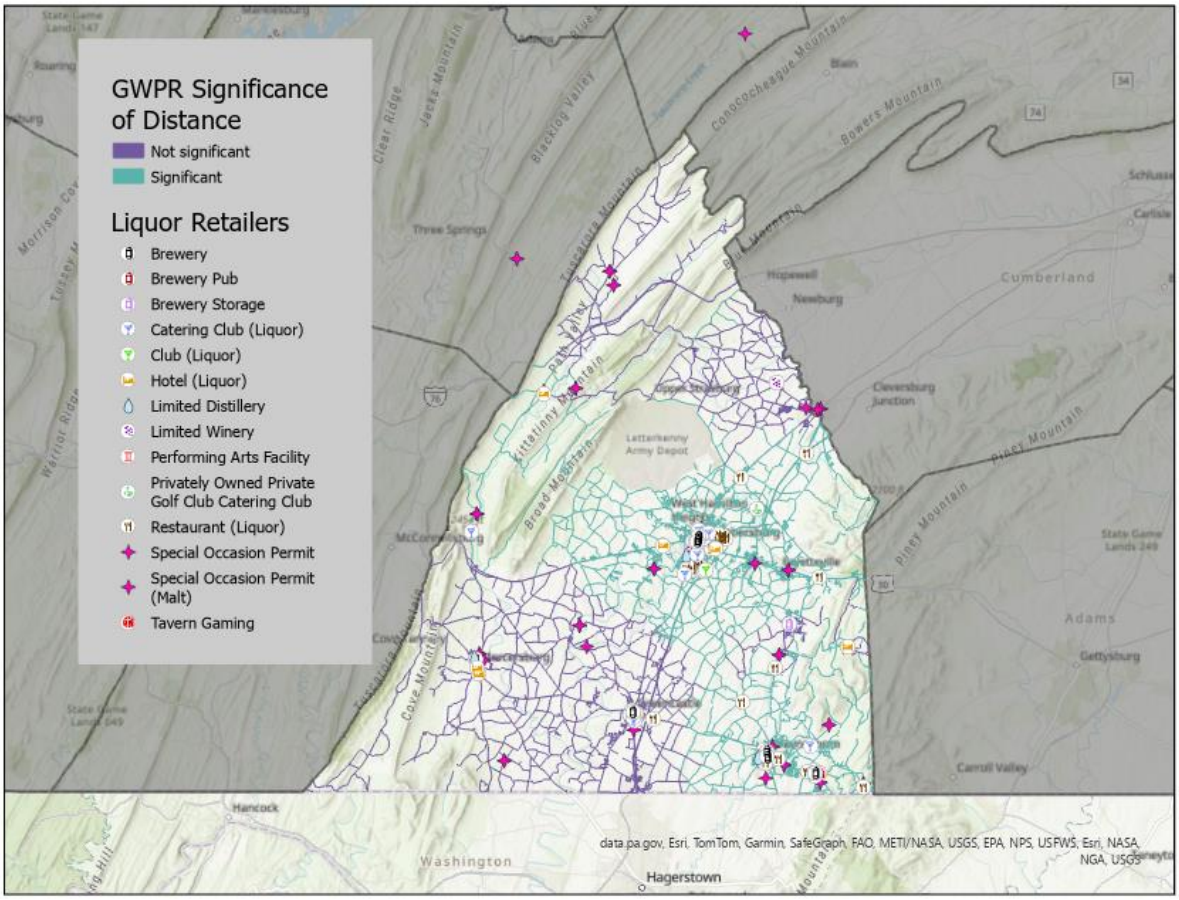


***Figure 1.7**: The relationship between the distance to an alcohol outlet and DUI crashes was significant in Chambersburg and Waynesboro.*

These results suggest that in Chambersburg and Waynesboro, individuals may be engaging more in social drinking and driving than in Greencastle and Mercersburg. A possible explanation is that these relationships arise from the number of outlets in the area. Excluding special occasion permit sites, Chambersburg and Waynesboro had 40 and 21 alcohol outlets, respectively, while Greencastle and Mercersburg had 7 and 4, respectively. Levine (2017) hypothesized that bars clustered in small areas encourage excessive drinking in four ways:

1. Problem and recreational drinkers tend to be attracted to areas with many bars
2. Bars may have features that encourage excessive drinking like crowds, music, or barhopping
3. Competition can lead to price reduction specials, like happy hours
4. Minors are more likely to be served alcohol where bar density is high (p. 160)

From these results, we believe that the high concentration of alcohol outlets in Chambersburg and Waynesboro are contributing to the high concentration of DUI crashes in those locations.

Spatial relationship of marijuana dispensaries and marijuana-related DUI crashes

There are only two dispensaries in Franklin County, and they are 3/4 mile away from each other in Chambersburg (PA Dept. of Health, n.d.). Because of this, and because there were 52 marijuana-related DUI crashes from 2013 to 2022, it is unlikely that any statistically significant patterns can be found between dispensary locations and marijuana DUI crashes.

Figure 1.8 maps the marijuana DUI crashes and the two dispensary locations. Marijuana DUI crashes were more dispersed, unlike alcohol DUI crashes. The first marijuana DUI crash in our Franklin County dataset occurred in August 2016; since then, each month had 0.67 marijuana DUI crashes on average.

There appeared to be a cluster of marijuana-related accidents in Waynesboro. Waynesboro is close to Maryland, but it is unlikely that these crashes originate from drivers commuting to Maryland to obtain marijuana for three reasons. First, the first marijuana crash in this dataset occurred in 2016, two years after Maryland's medical legalization and the same year as Pennsylvania's medical legalization (Nemphos Braue, 2023). Second, Maryland did not accept out-of-state medical cards during this study period (Ward, 2024). Lastly, recreational legalization occurred in 2023 (Nemphos Braue, 2023). Of the 14 crashes that occurred in the Waynesboro area, 31 drivers were involved, and 5 of them had Maryland drivers' licenses. It is unknown which of the drivers involved in the crash were under the influence of marijuana. Our discussion on the prevalence of substances in traffic stops in Question 2f can provide more insight.

Despite our inclination that Maryland was not a major source of marijuana DUI crashes in Waynesboro, driving after consuming marijuana may be more of an issue there. The low sample size of marijuana crashes reduces the reliability of statistical techniques to detect an effect. Furthermore, the marijuana crashes mapped in Figure 1.8 occurred over a six-year period, so those crashes were likely not related to each other.

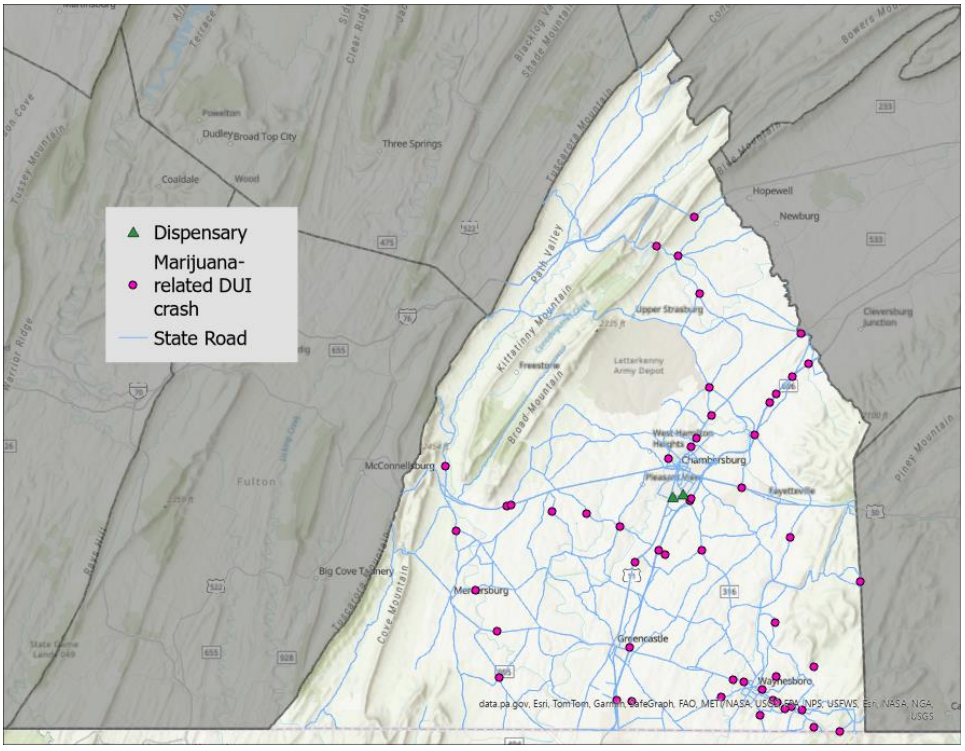


Figure 1.8: *A clustering of marijuana-related DUI accidents existed around Waynesboro from 2016-2022.*

1c. What times of day were DUI crashes most prevalent?

Knowing when DUI crashes are more prevalent can help inform public safety and enforcement patterns. Figures 1.9 and 1.10 show the frequencies of all crashes in Franklin County in the years 2013 to 2022 by the time of day in which they occurred. The distribution of crash time for all crashes strongly resembles that of a similar study (Liu, Li, & Khattak, 2020), with peaks in the standard commute times when traffic volumes increase and lows in the early morning. Synonymous with the same prior work, DUI crashes follow a different pattern, being more prevalent at night and the early morning. In fact, 33% of Franklin County crashes occurring between 12am and 5pm were DUI-related, while just 5% of crashes occurring between 6am and 5pm were DUI-related.

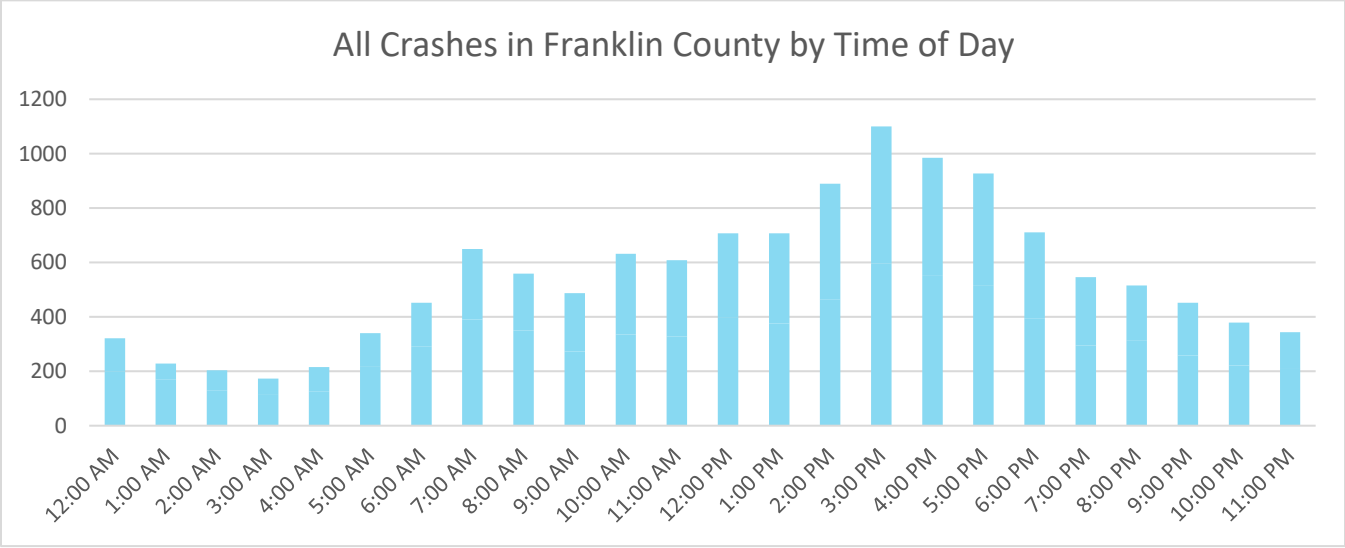


Figure 1.9: *Morning and evening commutes likely caused the spikes in crashes at 7:00 AM and 3:00 PM.*

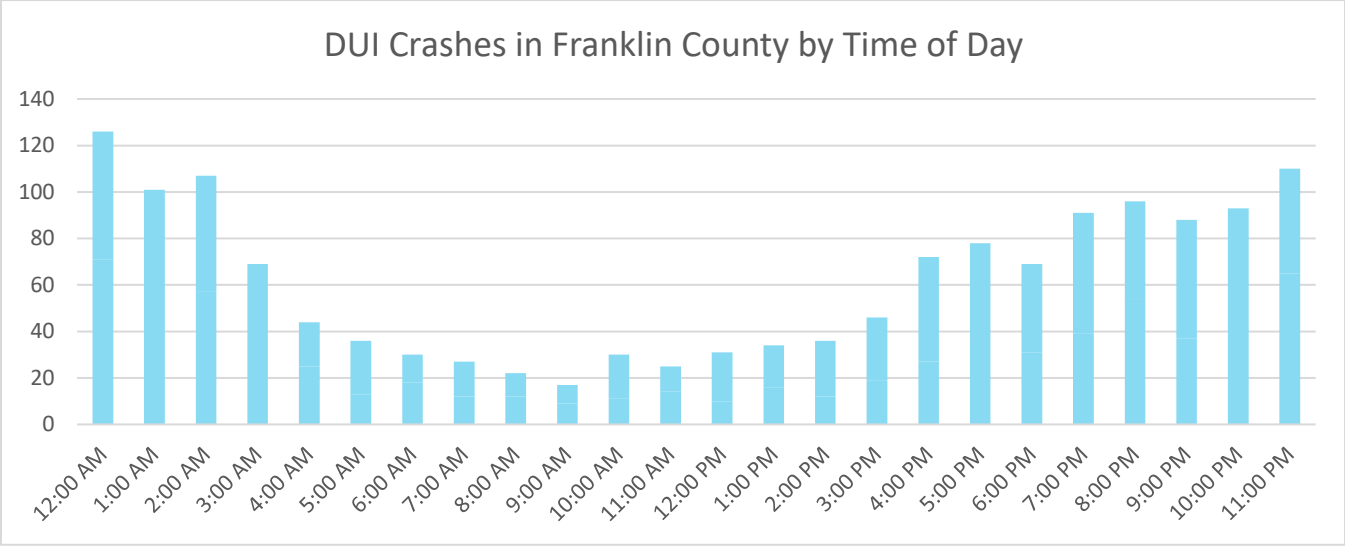


Figure 1.10: *DUI crashes were more likely to occur at night, when drinking is more common.*

1d. What was the variability of substances that were involved in DUI crashes, and what were the trends from the last decade?

We sought to understand how the substances involved in DUI crashes varied in the last decade. This can reveal trends in substance popularity or DUI behavior, which can help officials preemptively discourage substance usage by drivers via different enforcement and prevention strategies.

We found the proportions of all DUI crashes where alcohol, marijuana, and other substances were involved for each year. Note that the usage of different drugs in crashes was not mutually exclusive. In other words, the data for alcohol-related DUI crashes contained crashes where only alcohol was involved as well as crashes where alcohol was one of multiple substances used. This also applies to marijuana crashes and other substance crashes. The bar charts in Figures 1.11 and 1.12 show the number of DUI crashes where the respective substance was involved in red and the number of DUI crashes in which that substance was not involved in blue. Within each bar lay the percentage of DUI crashes in which the respective substance was involved for that year.

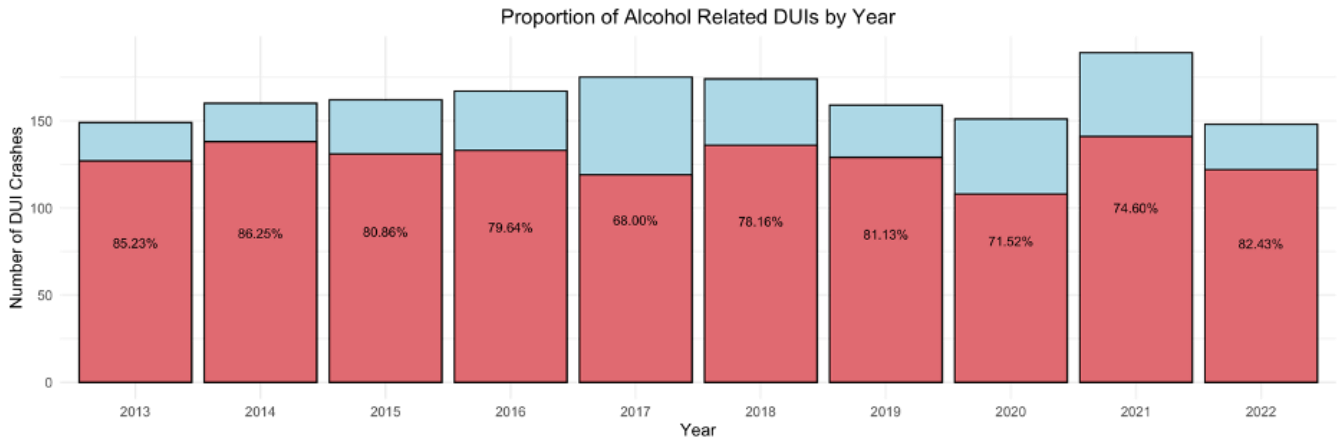


Figure 1.11: *The proportion of DUI crashes involving alcohol dipped in 2017 and 2020.*

Figure 1.11 reveals that in the last decade, the proportion of DUI crashes involving alcohol followed cycles of increase and decrease. Specifically looking at 2020 and two years and before and after it, it may be tempting to conclude that global events such as the COVID-19 pandemic may have been behind the dip in DUI related crashes due to social restrictions. However, we also see a similar dip in DUI related crashes in 2017, with an increase in non-alcohol DUI crashes.

Figure 1.12 interestingly suggests that Pennsylvania's legalization of medical marijuana in 2016 (*Getting Medical Marijuana in Pennsylvania*, n.d.) may have facilitated the irresponsible use of marijuana by drivers. However, it is important to note that Pennsylvania law criminalizes driving while at least 1ng/ml of cannabis metabolite is in a driver's bloodstream even without impairment, which is often the case weeks after ingestion (NORML, n.d.). It is possible that some of the involved drivers were responsible patients and had been driving unimpaired, but the responding officer noticed a medical card and charged a DUI (Delano, 2023). Our analysis in Question 1g investigates this possibility by examining injury and fatalities.

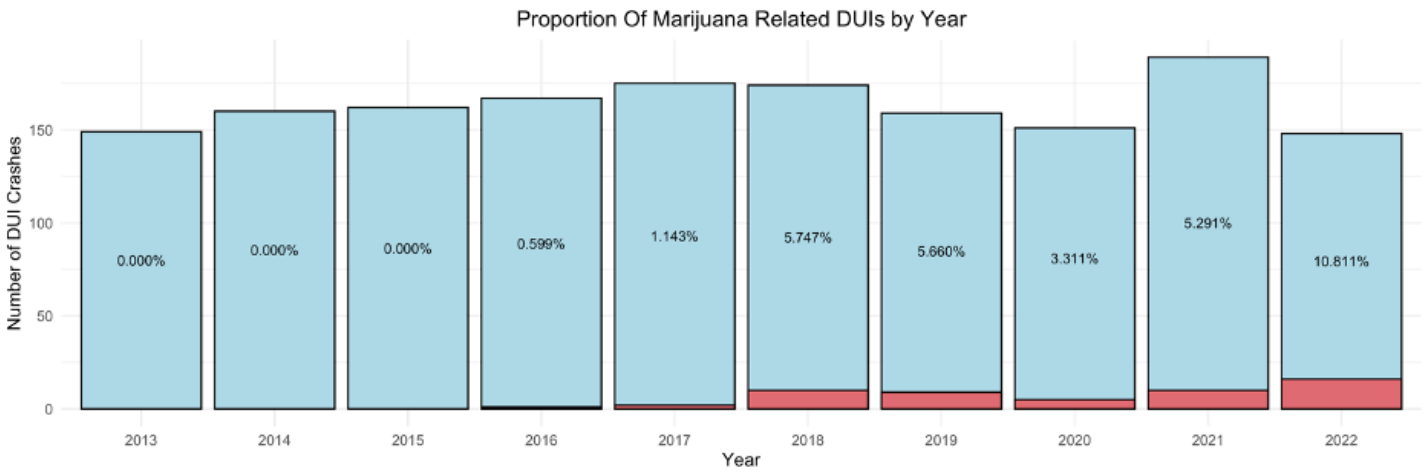


Figure 1.12: *Since the legalization of medical marijuana in 2016, the proportion of marijuana crashes has been nonzero.*

We can further insinuate from Figures 1.11 and 1.12 that a sizeable proportion of DUI crashes involved substances other than alcohol and marijuana. This was highest in 2017, when approximately 30% of DUI crashes involved other substances, and lowest in 2022, when this was around 7%.

1e. What were the demographics of individuals involved in DUI and non-DUI crashes? What were the trends from the last decade?

We sought to understand the characteristics and trends of those involved in DUI crashes. Specifically, we evaluated the distributions of age and sex throughout DUI crashes.[4] Doing so can illuminate if certain groups of people were more vulnerable to the misuse of certain substances which may lead to DUI offenses. This can help officials tailor their drug enforcement, intervention, and education strategies towards different demographic groups in an equitable manner. We made sure to compare the results between DUI and non-DUI crashes for contextualization.

Age

Figures 1.13 and 1.14 chart the proportion of individuals in each age group involved in non-DUI and DUI crashes for each year, respectively. First, these graphs demonstrate that DUI crashes tended to involve younger drivers, while non-DUI crashes tended to have larger shares of older drivers in Franklin County. However, they also demonstrate other differences in age representation. In Figure 1.13, the proportions of age group involvement in non-DUI crashes appear fairly consistent throughout the past decade. There were not any strong trends to indicate changes in the age demographics of those getting into non-DUI accidents.

[4] The race of the drivers was not included in the PennDOT crash datasets.

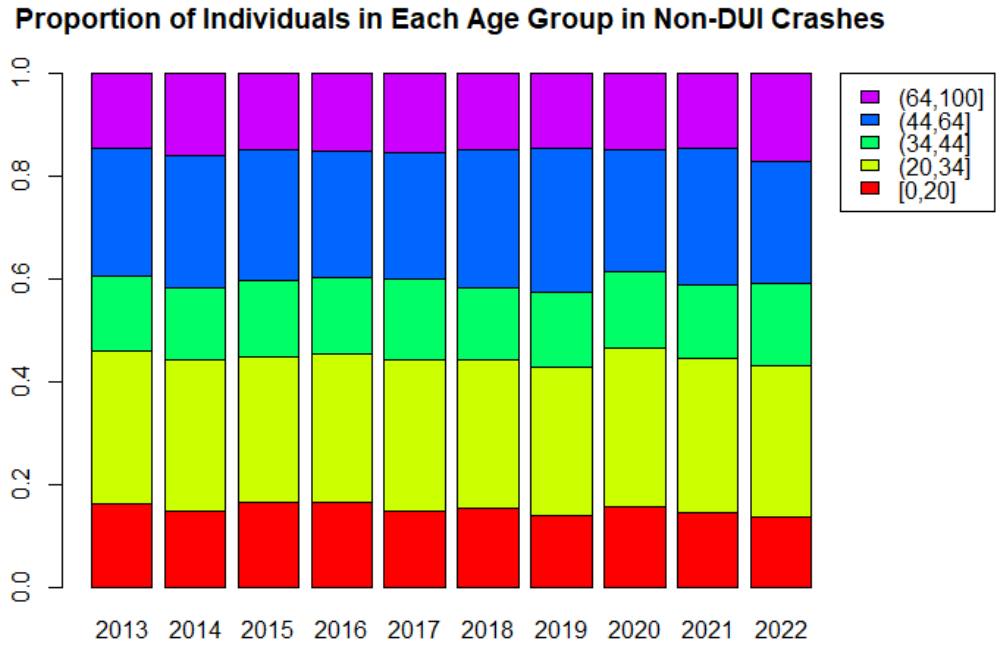


Figure 1.13: *There were no strong trends in the proportions of drivers from each age group involved in non-DUI crashes.*

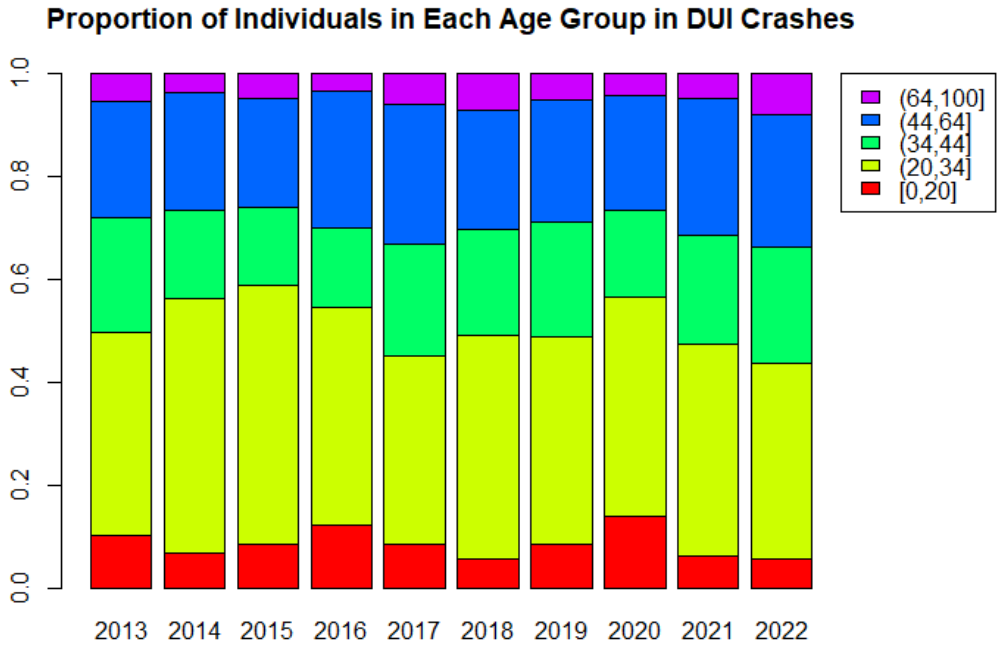


Figure 1.14: *The proportion of drivers aged 34 and under involved in DUI crashes experienced strong increases and decreases in the 10-year study period.*

Figure 1.14, however, shows greater variation. Individuals 34 and younger have the greatest representation by a larger margin in DUI crashes than in non-DUI crashes. Figure 1.14 may suggest that the proportion of younger drivers involved in DUI crashes may be influenced by societal or situational trends.

Figure 1.15 investigates the average DUI prevalence among all crashes for each age group. We computed the average proportion of drivers involved in DUI crashes relative to all crashes over the whole decade, for each of the six age categories. For each age group, we divided the total number of drivers involved in DUI crashes by the total number of drivers involved in all crashes in for each of the ten years. We then averaged the ten proportions to get the average prevalence of DUI in crashes for each age category over the last decade. The representation of different age groups in DUI crashes follows a roughly Normal distribution, with the age group of 21-34 year olds forming the highest represented group. That is, approximately 9% of crashes involving drivers aged 21-34 also involved DUI on average.

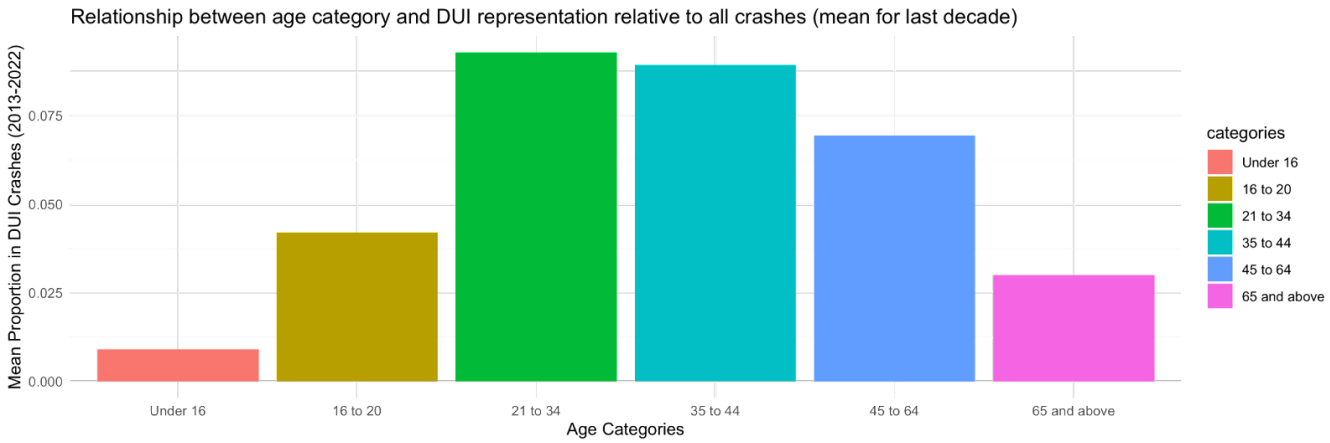


Figure 1.15: *The 21-34 age group of drivers has the highest representation in DUI crashes relative to all crashes in the last decade.*

Gender

Figures 1.16 and 1.17 demonstrate the rates of male drivers and female drivers involved in non-DUI crashes and DUI crashes, respectively. Again, as in Figures 1.13 and 1.14, there was much less variability of gender involvement among non-DUI crashes than DUI crashes. Female drivers were involved in 41% of non-DUI crashes and 26% of DUI crashes on average, indicating that male drivers were disproportionately more involved in DUI crashes relative to non-DUI crashes. For every female involved in a DUI crash, there were three males involved in similar incidents. Female involvement in DUI crashes increased to 33% in 2020, likely due to the pandemic; this suggests that female drivers may have been more susceptible to engaging in DUI during the turbulence brought on by the pandemic.

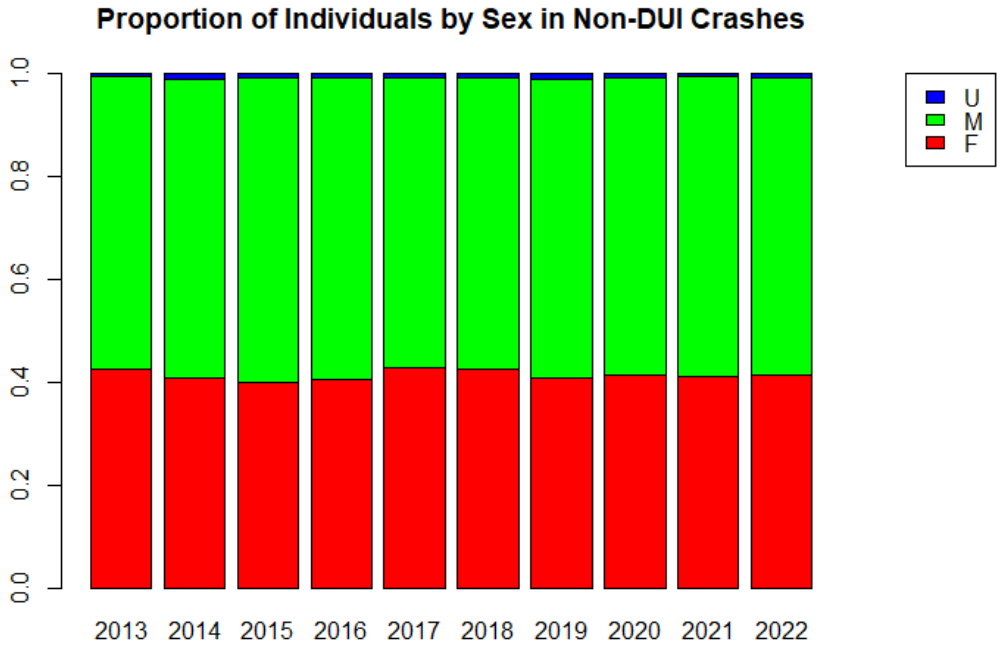


Figure 1.16: *The ratio of male to female drivers involved in non-DUI crashes was generally consistent throughout the study period.*

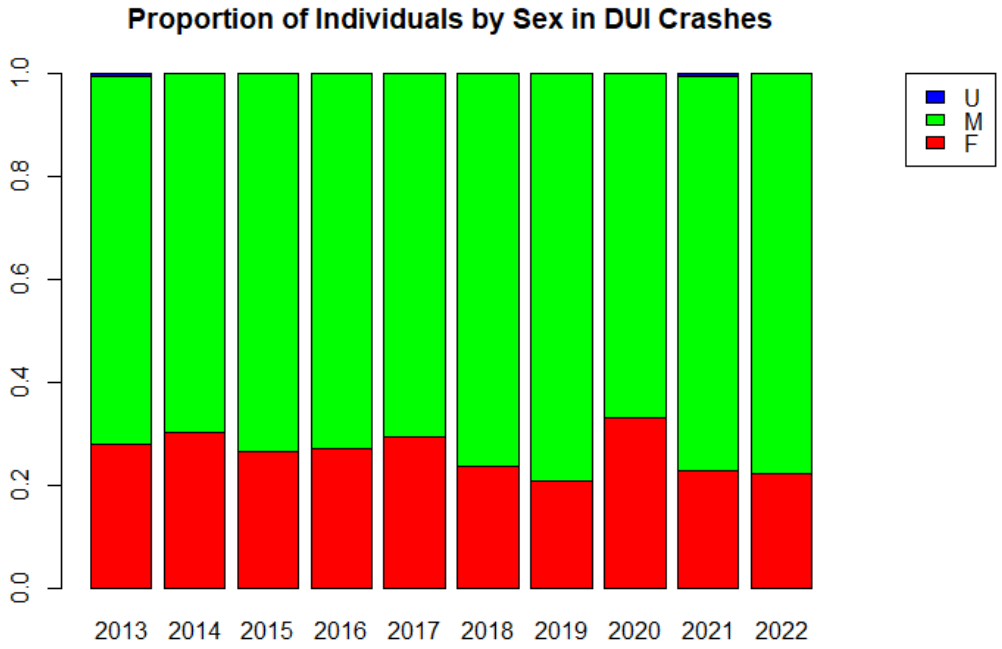


Figure 1.17: *Female drivers tended to have substantially less involvement in DUI crashes than male drivers.*

We followed the same methodology used for Figure 1.15 to obtain the average rate of DUI for each gender involved in an accident in Figure 1.18. Almost 5% of crashes involving a female driver involved DUI whereas around 8.5% of crashes involving a male driver involved DUI.

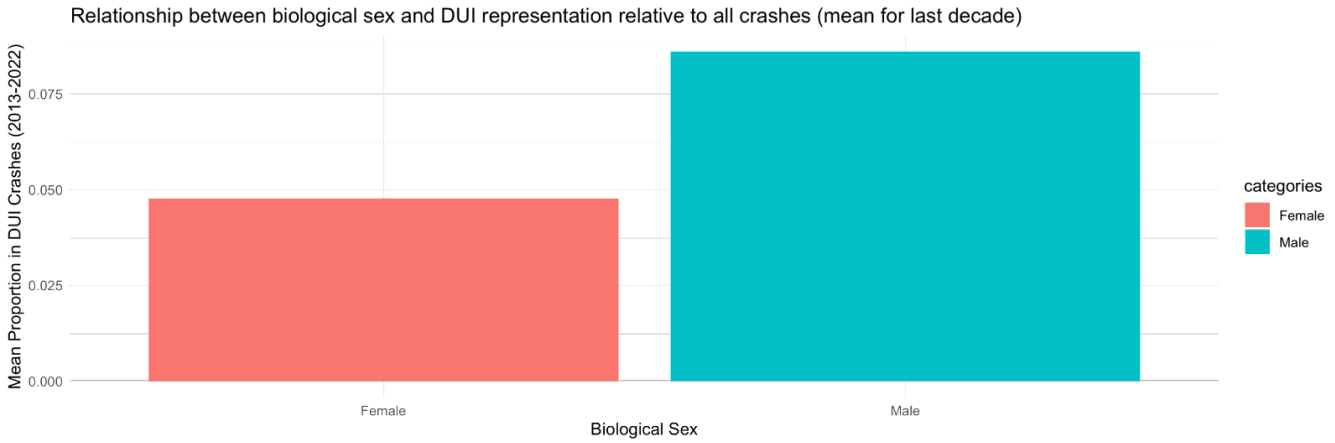


Figure 1.18: *Crashes involving men were almost twice as likely to involve a DUI as crashes involving women.*

1f. Did substance usage in DUI crashes differ between age groups or gender?

Age

We calculated the average rates of alcohol and marijuana for each age group over each year. Specifically, we determined the proportions of DUI crashes that involved alcohol and those that involved marijuana for each age group for each of the 10 years. We then averaged these 10 proportions for each age category. These proportions are plotted in Figures 1.19 and 1.20 respectively. Note that these proportions calculate the average prevalence of a substance, and do not imply that that substance was the only one involved. Further, there were no alcohol- or marijuana-related crashes involving drivers under 16, indicating that those crashes involved other substances.

Based on Figure 1.19, the distribution of alcohol DUI crashes relative to all DUI crashes was roughly Normal (bell-shaped). Drivers aged 35-44 involved in a DUI accident were the age group most likely to have been under the influence of alcohol. Those least likely to have used alcohol were in the 65 and older group. This suggests that drug use prior to driving may be more prevalent in the younger and older groups.

Figure 1.20 partially supports this by demonstrating that crashes involving drivers aged 16-20 were the most likely to have had a driver under the influence of marijuana. This inference is in tandem with the younger generations' more favorable attitude toward recreational marijuana use (Pew Research Center, 2013). The lowest proportion of marijuana-related DUI crashes was found in the 65 and older group.

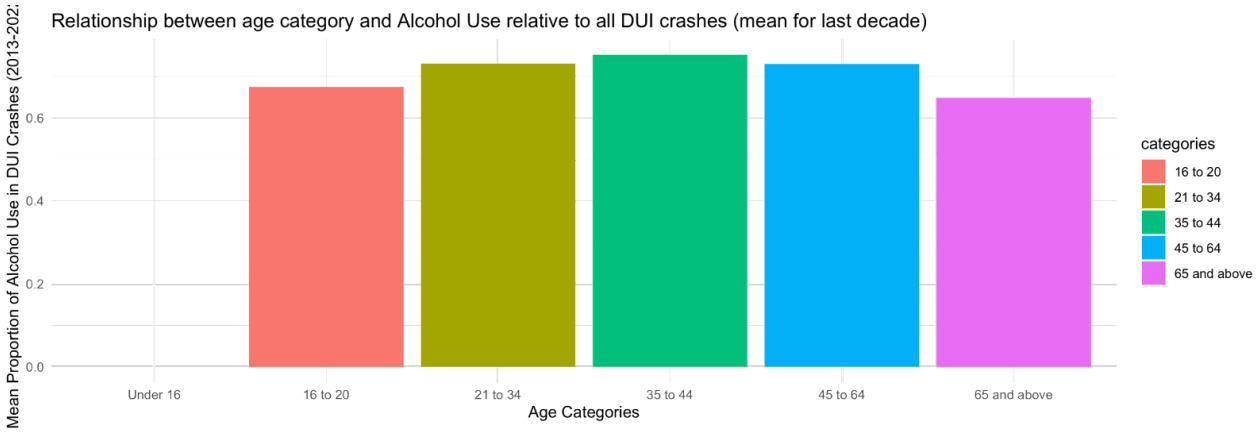


Figure 1.19: *The distribution of drivers involved in alcohol-related DUI crashes across age groups is roughly Normal.*

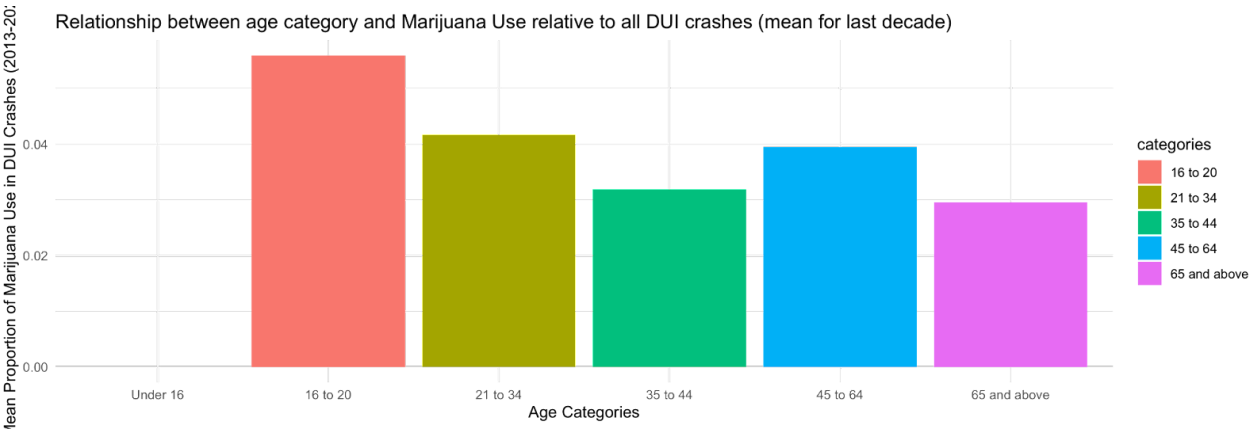


Figure 1.20: *Younger drivers were more likely to be involved in marijuana DUI crashes relative to other age groups.*

Gender

The distribution of drugs was almost exactly equal by gender. Female drivers were involved in 23.8% of crashes involving alcohol and 23.7% crashes involving marijuana. This suggests that drug use or the susceptibility of crashing was about the same between both examined genders and substances.

1g. Were DUI crashes more likely to involve serious injury or death than non-DUI crashes?

Each of the bar plots in Figures 1.21 and 1.22 represent the number of crashes each year and the proportion that resulted in either injury or fatality. Figure 1.21 shows the proportion of crashes involving injury or fatality for non-DUI crashes and Figure 1.22 shows the same for DUI crashes. In each of the ten years, DUI crashes had higher rates of injury or fatality. DUI crashes had approximately a 3-15% higher rate of serious injury or death compared to non-DUI crashes. Fortunately, it appears that both non-DUI and DUI crashes have generally become less injurious over the past decade.

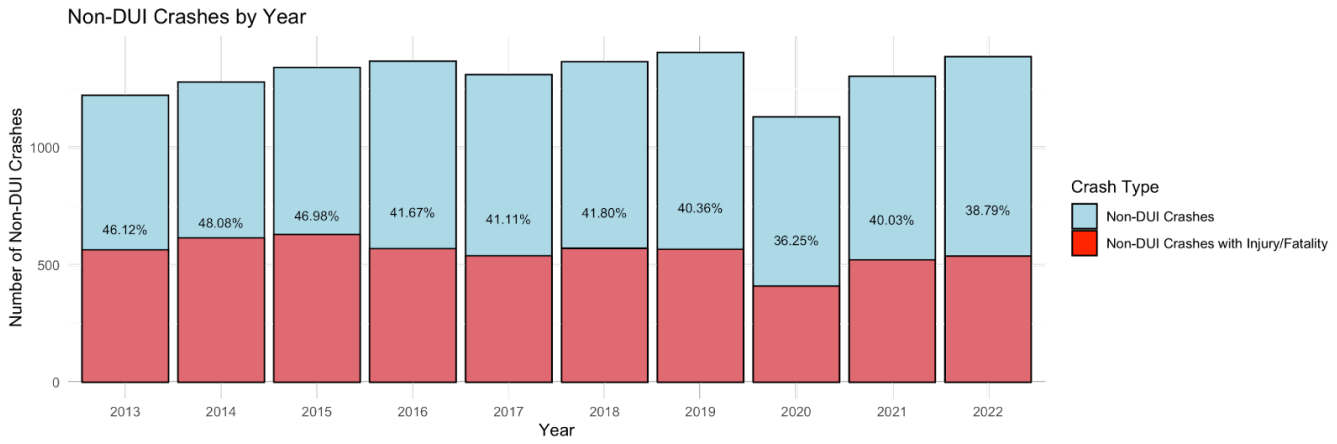


Figure 1.21: *In 2020, both the absolute number of non-DUI crashes decrease and the proportionate number of those crashes resulting in an injury or fatality.*

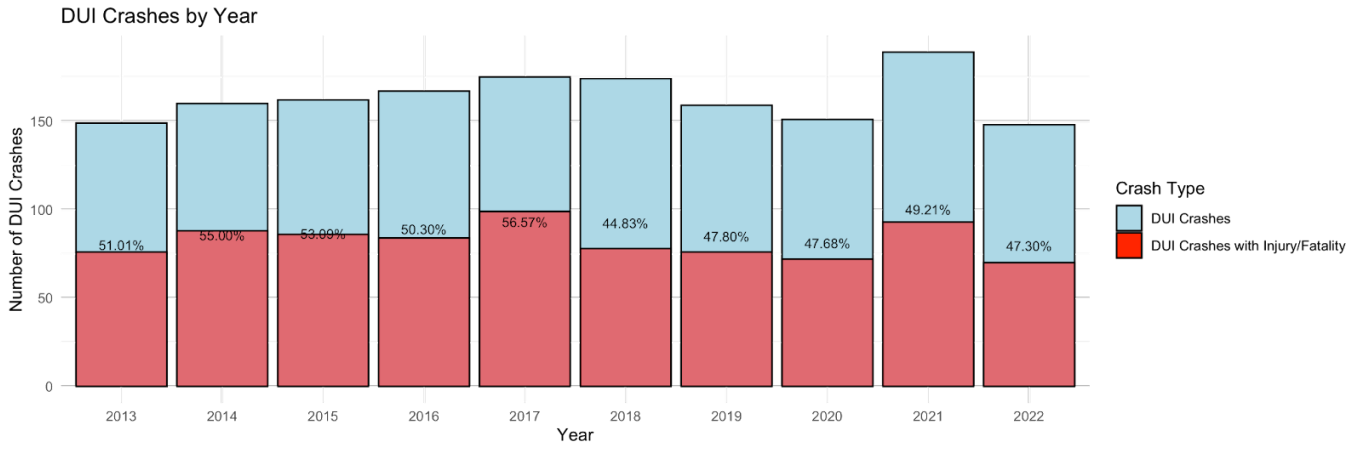


Figure 1.22: *In contrast to Figure 1.21, the pandemic did not substantially reduce the proportion of DUI crashes that resulted in injuries or fatalities compared to the previous years.*

To rigorously validate whether DUI was significant in affecting the likelihood of serious injury or death in an accident, we employed a logistic regression model. Logistic regression and similar techniques have frequently been used by past researchers to analyze the likelihood of injuries or deaths in crashes (Chen et al., 2016; Lidbe et al., 2020; Liu, Li, & Khattak, 2020). We used all crashes that occurred in Franklin County between 2013 and 2021.[5]

[5] We excluded 2022 because the 2022 dataset did not contain a variable documenting the weather conditions, which we believed to be significant.

Variable	*n* (%)
At least one individual was injured or killed	5,737 (43.6%)
Year of crash	
2013	1,361 (10.3%)
2014	1,442 (10.9%)
2015	1,490 (11.3%)
2016	1,520 (11.6%)
2017	1,473 (11.2%)
2018	1,540 (11.7%)
2019	1,559 (11.9%)
2020	1,274 (9.7%)
2021	1,493 (11.4%)
Season of crash	
Winter	3,600 (27.4%)
Spring	3,092 (23.5%)
Summer	3,137 (23.9%)
Autumn	3,323 (25.3%)
Weather conditions	
Clear	10,683 (81.2%)
Cloudy	123 (0.9%)
Fog, smog, or smoke	112 (0.9%)
Freezing rain or drizzle	34 (0.3%)
Rain	1,430 (10.9%)
Sleet or hail	53 (0.4%)
Snow	620 (4.7%)
Unknown weather	97 (0.7%)
PSP responded to the crash	9,045 (68.8%)
Time of day	
12am-5am	1,485 (11.3%)
6am-11am	5,321 (40.5%)
12pm-5pm	3,387 (25.8%)
6pm-11pm	2,949 (22.5%)
Included at least one driver under 20 years old	2,978 (22.6%)
Number of drivers	
1	6,124 (46.6%)
2	6,226 (47.3%)
3+	802 (6.1%)
At least one driver was asleep or fatigued	381 (2.9%)
At least one individual was unbelted	1,289 (9.8%)

Table 1.4: *The counts and proportions of Franklin County crashes with each of the listed characteristics (continued on page 27).*

Logistic regression models the likelihood that a crash resulted in injury or death of at least one person involved in the crash. We selected other variables for inclusion based on the significant results of prior research (Chen et al., 2016; Liu, Li, & Khattak, 2020; Liu & Fan, 2019). To ensure model stability and reliability, we excluded all crashes that, in any variable, had values that occurred less than 30 times in the dataset. We also removed all crashes that did not have valid coordinates. There were 13,152 crashes used in the model. A description of the data is in Table 1.4.

Table 1.5 records the results of the logistic regression model. The column “OR” lists odds ratios, which are a measure of association between the outcome (injury or death) and the predictor. Odds ratios close to 1 indicate that the odds of injury or death occurring and not occurring are about the same. Odds ratios greater than 1 indicate that injury or death is more likely to occur with that variable. Odds ratios less than 1 indicate that injury or death is less likely to occur with that variable. The *’s next to the odds ratios indicate the statistical significance of the result. Odds ratios without a * were not significant, meaning that the

At least one driver was not from Pennsylvania	2,924 (22.2%)
Local road only	159 (1.2%)
Curved road	2,505 (19.0%)
Number of passengers	
0	228 (5.0%)
1	2,643 (57.5%)
2	969 (21.1%)
3	411 (8.9%)
4	197 (4.3%)
5	74 (1.6%)
6+	78 (1.7%)
Collision type	
Angle	3,591 (27.3%)
Backing/Other	467 (3.6%)
Head-on	565 (4.3%)
Hit fixed object	4,560 (34.7%)
Hit pedestrian	232 (1.8%)
No collision	585 (4.4%)
Rear-end	2,503 (19.0%)
Sideswipe (opposite side)	225 (1.7%)
Sideswipe (same side)	424 (3.2%)
Illumination	
Dark	109 (0.8%)
Dark, with lights	1,295 (9.8%)
Dark, no lights	2,687 (20.4%)
Dawn	267 (2.0%)
Daylight	8,503 (64.7%)
Dusk	291 (2.2%)
At least one driver was under the influence of drugs	463 (3.5%)
At least one driver was under the influence of alcohol	1,156 (8.8%)
Total	*13,152*

Table 1.4 *(continued)*

model did not detect a significant relationship between the odds of injury and the variable. To interpret an odds ratio, subtract 1 from it and then multiply by 100 to get the percentage increase or decrease of the odds of injury or fatality.

Importantly, net of all other considered variables, drivers who were under the influence of drugs were associated with a significant (1.707 – 1) * 100% = 71% increase in the odds of injury or fatality. Drivers under the influence of alcohol were associated with a significant 37% increase in the odds of injury or fatality. Other researchers have also found similar results, if smaller in magnitude (Liu et al. (2020) found that driving under the influence increased the likelihood of injury by 23% in Southeastern Michigan crashes).

In sum, we found statistically significant evidence that driving while intoxicated makes crashes more dangerous, net of all other considered factors in this analysis.

Variable	OR	95% CI
Year of crash	0.953***	0.939-0.967
Season of crash (Ref = Autumn)		
Winter	1.015	0.915-1.125
Spring	1.099	0.991-1.219
Summer	0.822***	0.739-0.913
Weather conditions (Ref = Clear)		
Cloudy	1.068	0.727-1.568
Fog, smog, or smoke	0.905	0.602-1.359
Freezing rain or drizzle	0.617	0.277-1.374
Rain	0.741***	0.656-0.836
Sleet or hail	0.721	0.395-1.317
Snow	0.541***	0.444-0.659
Unknown weather	0.758	0.483-1.189
PSP responded to the crash	1.209***	1.11-1.316
Time of day (Ref = 12am-5am)		
6am-11am	1.141	0.951-1.369
12pm-5pm	1.088	0.902-1.311
6pm-11pm	1.208*	1.045-1.396
Included at least one driver under 20 years old	0.803***	0.734-0.878
Number of drivers (Ref = 1)		
2	1.763***	1.473-2.11
3+	2.682***	2.128-3.379
At least one driver was asleep or fatigued	1.29*	1.035-1.608
At least one individual was unbelted	2.954***	2.596-3.361
At least one driver was not from Pennsylvania	0.936	0.856-1.024
Local road only	1.183	0.839-1.669
Curved road	1.136*	1.026-1.257
Number of passengers (Ref = 0		
1	1.581***	1.44-1.736
2	1.581***	1.372-1.821
3	1.678***	1.36-2.071
4	1.819***	1.346-2.46
5	1.905**	1.168-3.108
6+	2.79***	1.678-4.64
Collision type (Ref = Angle)		
Backing/Other	0.424***	0.319-0.563
Head-on	1.543***	1.278-1.863
Hit fixed object	1.159	0.953-1.408

Table 1.5: *Results from the logistic regression found that DUI significantly increased the odds of injury or death in an accident* *(continued on page 29).*

Hit pedestrian	297.216***	72.974-1210.531
No collision	1.944***	1.524-2.48
Rear-end	0.87*	0.78-0.972
Sideswipe (opposite side)	0.896	0.677-1.186
Sideswipe (same side)	0.524***	0.415-0.663
Illumination (Ref = Dark)		
Dark, with lights	0.677	0.441-1.038
Dark, no lights	0.793	0.522-1.204
Dawn	0.824	0.502-1.352
Daylight	0.867	0.566-1.328
Dusk	0.936	0.58-1.51
At least one driver was under the influence of drugs	1.707***	1.394-2.09
At least one driver was under the influence of alcohol	1.369***	1.188-1.578
Total Observations	*13,152*	
Pseudo R^2		
McFadden	*0.089*	
Cox & Snell	*0.115*	
Nagelkerke	*0.154*	

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1.5 (*continued)***

Notably, only 36 out of 463 (7.7%) drug-related crashes between 2013 and 2021 involved marijuana. This likely explains the higher likelihood of injury or death from drugs than alcohol, as numerous studies have found that other drugs and alcohol are more dangerous than marijuana when driving. Several papers found no evidence (Neavyn et al., 2014; Romano et al., 2013) or marginal evidence (Neavyn et al., 2014; Romano & Voas, 2011; Romano, Voas, & Camp, 2017) that marijuana by itself induces crashes or fatalities. It was found to contribute less to crashes and fatalities than other drugs and alcohol (Marillier & Verstraete, 2019; Romano et al., 2013; Romano & Voas, 2011). Combining substances has been found to increase the odds of injury or death (Neavyn et al., 2014; Romano & Voas, 2011). While marijuana has been shown to exert some effects on driving ability, impairment, and crashes in the studies cited here, the misuse of other drugs (prescribed and illicit) has been shown to be more concerning in a DUI context. Therefore, we recommend that Franklin County prioritize curbing other drug-related and alcohol-related DUI behavior.

We discuss some other important results from the logistic regression model. First, crashes that involved an unbelted individual were 195.4% more likely to involve an injury or fatality. This was the second-largest odds ratio in the model, indicating that seatbelts were very influential in the odds of a crash causing injury or death. This result is in strong agreement with prior research (Lidbe et al., 2020). The largest odds ratio in the model was for the collision type for hitting a pedestrian, with an incredible 2,970% increase in the odds of injury or death. The pedestrians were most likely the individuals who were injured or killed.

While younger drivers may be viewed as more reckless (Martin et al., 2013), crashes with drivers under 21 were 20.1% less likely to cause injury or death. Some prior research also reached this conclusion (Chen et al., 2016; Liu & Fan, 2019). Also, rain and snow significantly reduced the odds of injury or death when compared to clear conditions. While these conditions may decrease visibility or increase the wetness of

the road, people tend to drive slower in the rain and snow, resulting in less severe injury when crashes occur (Liu & Fan, 2019).

Having passengers increased the odds of injury or death, from a 58% increase with one passenger to a 179% increase with 6 or more passengers. This is intuitive, as the more individuals are involved, the more people there are that can be injured. Additionally, passengers can distract drivers, potentially increasing the odds of a crash in the first place, though the likelihood of a crash occurring is not modeled here.

1h. What other driving hazards or consequences correlated with substance use in crashes?

Table 1.6 shows the percentages of non-impaired and impaired-driver crashes that involved these circumstances. These statistics can be used in promotional or diversionary materials to warn Franklin County residents about the dangers of DUI.

Impaired-driver crashes were less likely to involve multiple vehicles, but they were more likely to hit fixed objects like poles, parked vehicles, and trees. Impaired-driver crashes more frequently involved lane departures and drivers were more likely to engage in dangerous behaviors like not wearing seatbelts and speeding.

Crash characteristic	Percentage of sober crashes that involved...	Percentage of impaired crashes that involved...
Hitting a parked vehicle	3.4%	13.1%
Hitting a pole	10.5%	19.5%
Hitting a tree	5.9%	11.3%
Hitting a fixed object	31.5%	61.0%
An injury or fatality	42.5%	50.6%
A lane departure	35.4%	64.3%
Overturning the vehicle	6.9%	14.1%
Speeding	2.8%	8.7%
An unbelted individual	8.3%	21.4%
An intersection	31.4%	18.3%
Multiple vehicles	60.1%	35.7%

Table 1.6: *Percentages of crashes that involved each factor demonstrates that crashes with impaired drivers were more likely to involve dangerous behaviors and more severe outcomes.*

PART II: DUI STOPS AND ARRESTS

Research Questions

2a. What proportion of stops resulted in DUIs, and what were the trends?

2b. Where were DUI stops most prevalent? When were stops most prevalent?

2c. What proportion of stopped drivers lived in zip codes outside Franklin County? What proportion lived outside Pennsylvania?

2d. What were the race, gender, age, and ethnic demographics of stopped drivers?

2e. What was the BAC distribution in Franklin County, and how many arrests were made?

2f. What was the distribution of substances in DUI traffic stops? What was the prevalence of other charges?

Primary Findings

- DUI stops and DUI crashes align spatially throughout the county except for I76, which may be under-policed for DUI.
- When accounting for the time between arrest and a blood test, almost two-thirds of BACs were below 0.02, the BAC for one drink.
- There may exist a responsible population of drivers who do not drive after having 2-4 drinks. Alternatively, those with the proclivity to drive impaired may have harder drinking habits than those without it.
- Alcohol was involved in 58% of DUI traffic stops. Alcohol and drug combinations occurred in 6.2% of DUI traffic stops.

Methodology and Data

We used both CAD and CDR datasets from the PSP to analyze patterns and trends in traffic stops.

It is imperative to note that assessing DUI prevalence with traffic stop and enforcement rates has a major drawback. National self-report data reveals that people drive under the influence much more frequently than arrest rates make it appear (Bouffard, Niebuhr, & Exum, 2017). The FBI reported 646,000 DUI arrests in 2020 (Federal Bureau of Investigation, n.d.), which was just 0.5% of the nation's driving-aged population (U.S. Census Bureau, 2020). However, the National Survey on Drug Use and Health found that 7.2% of respondents aged 16 or older drove under the influence of alcohol or illicit drugs in 2020 (Substance Abuse and Mental Health Services Administration, 2022). Back in 2008, the National Highway Traffic Safety Administration found that 20% of drivers drove within 2 hours of consuming alcohol at least once in the past year, and that 30% of them had driven when they thought they were over the legal limit at least once in

that time (Drew et al., 2010). Consequently, DUI rates estimate enforcement better than they estimate behavior. DUI arrest rates may also reflect the normative culture of alcohol acceptance, as Rookey (2012) found that areas with stronger anti-drinking norms tended to have higher arrests per population.

Results

2a. What proportion of traffic stops resulted in DUIs, and what were the trends?

There were 54,146 traffic stops from PSP CAD records in Franklin County between January 1, 2020, and September 30, 2023. Of these, 932 had a final call type regarding a DUI (1.7%). Going by quarters, we examine the trends over time in proportion in Figure 2.1.

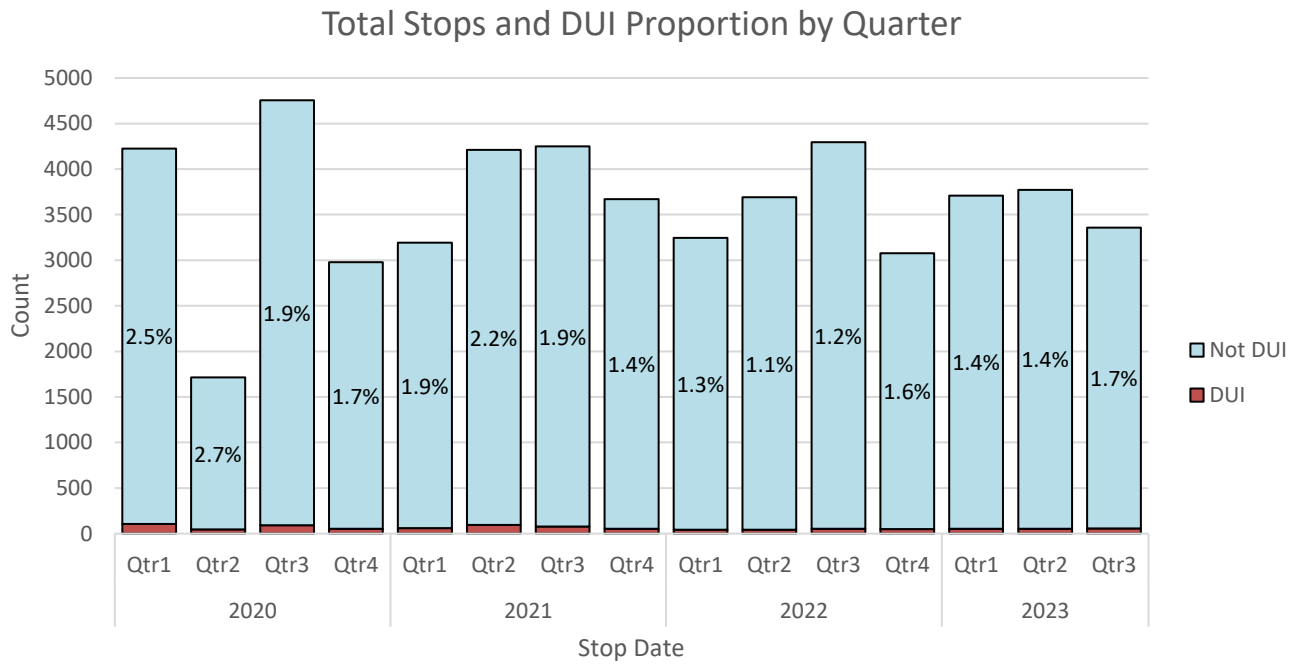


Figure 2.1: *The number of stops that resulted in a DUI generally decreased after the second quarter of 2020, when lockdowns began.*

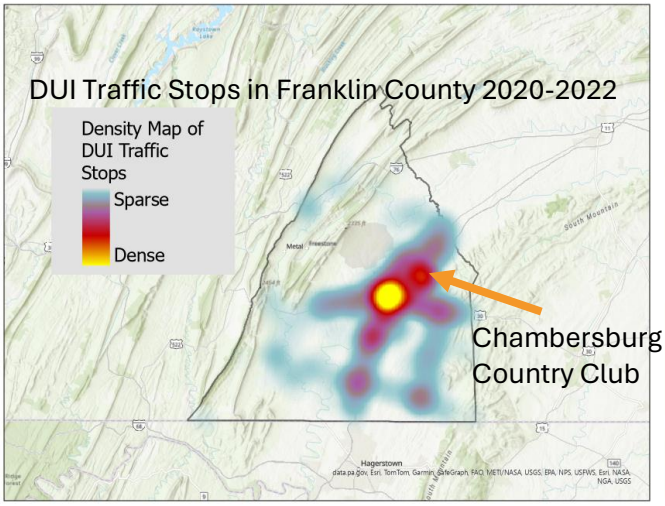
The percentage of stops resulting in DUI ranged from 2.7% in March-May 2020 and 1.1% in March-May 2022. There was substantial variability in stop counts each quarter, seemingly following a pattern where Quarters 2 and 3 had more stops than Quarters 1 and 4 post-2020. Notably, the counts of DUI and non-DUI stops followed trends that were more like each other than trends of DUI and non-DUI crashes in Figure 1.1; that is, DUI and non-DUI stops tended to increase and decrease at nearly the same times and at similar magnitudes, while crashes did not see this pattern. As we suspected, this suggests that traffic stops may not adequately capture DUI occurrences. Rather, they are more a function of police presence and enforcement. This is certainly not unique to Franklin County.

2b. Where were DUI traffic stops most prevalent? When were DUI traffic stops most prevalent?

Where were DUI traffic stops most prevalent?

Figure 2.2a maps the density of DUI traffic stops throughout Franklin County. DUI stops clustered in Chambersburg, with some dense areas in Greencastle and Waynesboro. A dense region of DUI stops was just outside the Chambersburg Country Club, which had a liquor license, and Chambersburg Mall as well.

Figure 2.2b maps the density of DUI crashes between 2020 and 2022 for an elementary comparison between crashes and enforcement. There are definite similarities. Chambersburg, Greencastle, and Waynesboro were dense regions for DUI stops and crashes. However, the stretch of I76 in Northern Franklin County had a higher crash density compared to traffic stop density. This could mean that I76 is under-policed for DUI.



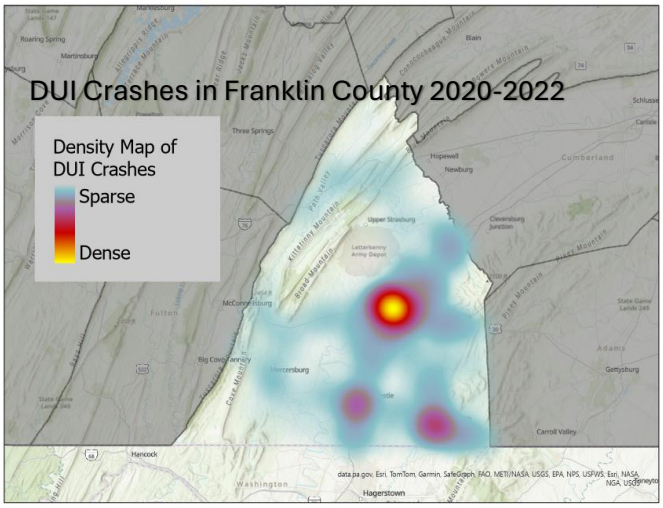


Figure 2.2: (a, left) *DUI traffic stops clustered in Chambersburg and the surrounding highway system, with a cluster at the country club.*

Figure 2.2: (b, right) *The density map of DUI crashes from 2020 to 2022 reveals similarities to that of DUI traffic stops, suggesting that the PSP was generally patrolling the proper regions.*

When were DUI traffic stops most prevalent?

Figure 2.3 shows the distribution of the time of DUI traffic stops in Franklin County between January 1, 2020, and September 30, 2023. Similar to the time distribution of DUI crashes in Figure 1.10, DUI stops were most prevalent in the early morning hours and late night hours.

It is important to note that while traffic stops resulting in DUI are a good indicator of offending frequency, they are subject to bias. Where and when the Troopers are on patrol as well as how many Troopers there are can affect the number of stops resulting in DUIs.

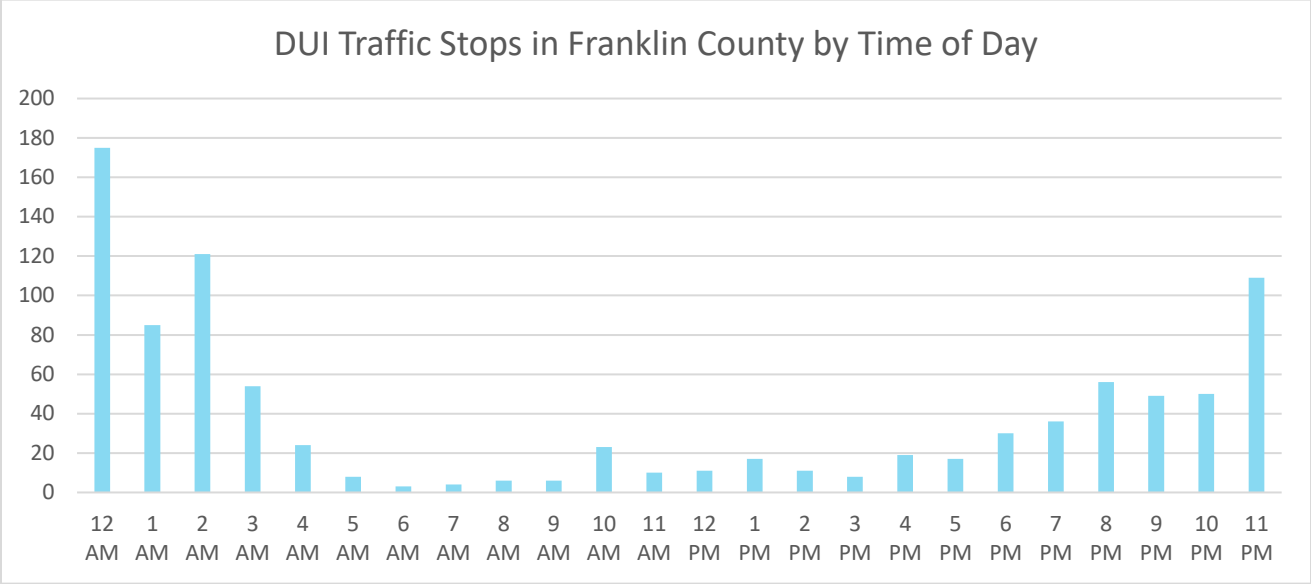


Figure 2.3: *As with DUI crashes, DUI stops were most likely to occur in the late evening and early morning hours.*

Spatial trends

As we did for crashes in Question 1a, we used Emerging Hot Spot Analysis to find hot spots of traffic stops and stops resulting in a DUI (see the methodology of Question 1a for a detailed description). The resulting map is in Figure 2.4. The results mimic the Emerging Hot Spot Analysis we performed on DUI crashes. Chambersburg had a sporadic hot spot region, but there was a consecutive hot spot region on Route 30, west of Chambersburg. According to ESRI (n.d.), this region marks a sequence of at least two significant hot spots in the final months and was never a hot spot prior to then. This may be the result of a DUI checkpoint, which was reported in August of 2023 by the Tri-State Alert (2023). From these results, we are confident that DUI enforcement remained fairly consistent spatially throughout the investigation period.

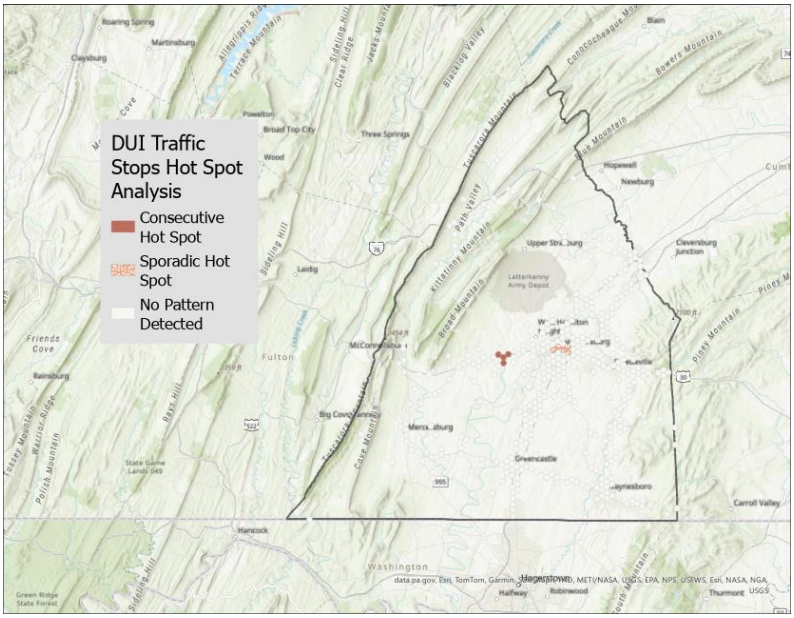


Figure 2.4: *Like the DUI crash hot spot analysis, there were not any important spatial-temporal trends in DUI traffic stops.*

2c. What proportion of DUI-stopped drivers lived in zip codes outside Franklin County? What proportion lived outside Pennsylvania?

The CDR dataset contained a variable for the zip code of the stopped driver's license. Using a shapefile of zip codes in the country, we calculated the number of stops with drivers from each zip code to visualize where these drivers lived. There were 21 zip codes associated with the 52 Franklin County DUI CDRs. Figure 2.5 contains the map limited to Pennsylvania for visibility. Fifteen zip codes were Pennsylvanian and 8 of those were in Franklin County. Three zip codes were in Maryland, one was in Virginia, and one was in West Virginia. One zip code, 7196, may be the borough of zip code 17042 near Hershey, PA.

Franklin County driver's licenses comprised half (26) of the records, and Pennsylvanian licenses were nearly 80% (41). The remaining 20% came from Maryland with 8 DUIs (15%) and Virginia, West Virginia, and 7196 each contributing 1 DUI. These statistics are described in Table 2.1.

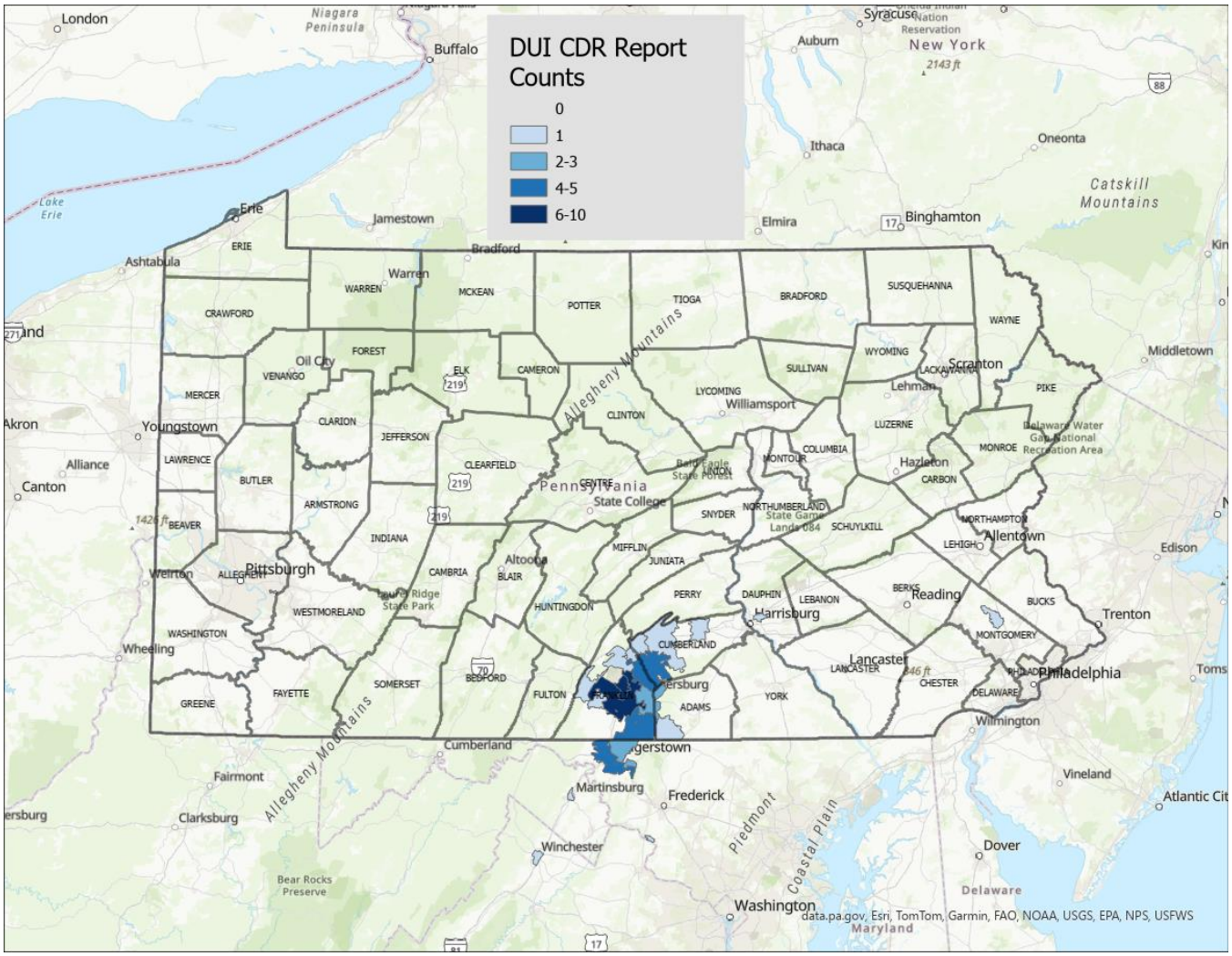


Figure 2.5: *Most CDR records with a DUI concerned drivers originating from Pennsylvania.*

Zip Code Location	Number of Zip Codes	Number of DUIs from that area	Percentage
Pennsylvania	15	41	78.8%
Franklin County	8	26	50.0%
Not Franklin County	7	15	28.8%
Maryland	3	8	15.4%
Virginia	1	1	1.9%
West Virginia	1	1	1.9%
7196	1	1	1.9%

Table 2.1: *Descriptive statistics on the zip codes involved in DUI from the CDR records.*

2d. What were the race, ethnicity, gender, and age demographics of stopped drivers?

Race and ethnicity

The CDR dataset contained information about the driver's race, gender, age, and ethnicity. Recall that there were only 52 CDRs in Franklin County that registered as a DUI, so statistical significance was not possible to ascertain. Additionally, Troopers do not ask drivers to provide their racial identity; as such, the recorded races are what the Trooper perceived the driver's race to be (Engel et al., 2023). Therefore, the descriptive results in Table 2.2 should be interpreted conservatively. Of all stopped Black drivers, 1.3% were given a DUI citation. Of all stopped White drivers, 1.1% were given a DUI citation. Of all stopped Hispanic drivers, 2.8% were given a DUI citation.

All Stops (4,680)	DUI Stops (52)
81% White (3,779)	81% White (42)
16% Black (756)	19% Black (10)
2% Asian (73)	
1% Unknown (58)	
<1% American Indian/Alaskan Native (13)	
<1% Two or More (1)	
12% Hispanic (543)	29% Hispanic (15)

Table 2.2: *The distribution of White and Black drivers in all traffic stops and DUI traffic stops were similar.*

Age

Two drivers with ages 0 and 1 were removed for the age analysis. The average age of a stopped driver was 38 years; for a stopped driver with a DUI, the average age was 34 years. Figure 2.6 shows the age distribution of individuals stopped for DUI. While the counts are low, individuals under 29 have the greatest representation in DUI CDR records.

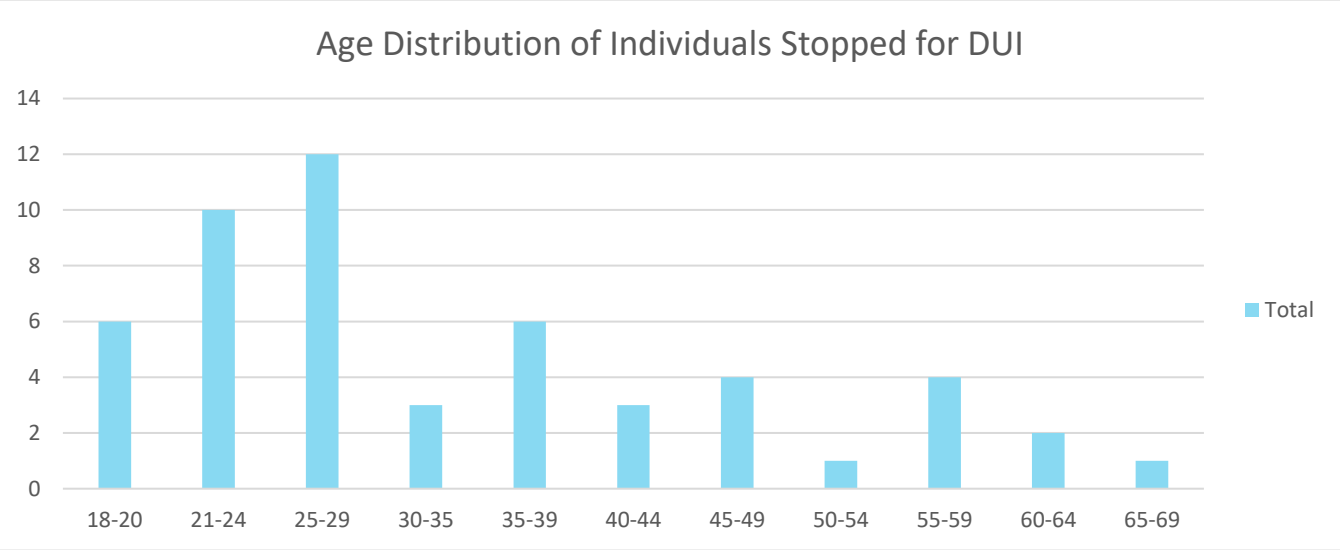


Figure 2.6: *Younger adults were more prevalent in DUI CDR records than older adults.*

Gender

Two-thirds (3,112) of CDRs concerned male drivers. Conversely, 81% (42) of DUI CDRs concerned male drivers. Considering that we found that men were twice as likely to be involved in DUI crashes relative to their presence in all crashes than women in Question 1e, this result supports the argument that men are a group that is susceptible to committing this offense. Prior research supports this as well. A 2015 paper studying first-time Pennsylvanian DUI offenders from 2006-2007 found that 79% of the offenders were male (Knoth, 2015). Another work published by the State Highway Administration of Maryland found that 71% of first-time Maryland DUI recipients in 2008-2009 were male (Ahmed, Farkas, & Beck, 2011). An older study analyzing DUI offending across the nation found that males were four times more likely to drive after drinking than females (Miller, Levy, & Lestina, 1998). Stringer (2021) found that males were 2-3 times more likely than females to engage in DUI.

2e. What was the BAC distribution in Franklin County, and how many arrests were made?

The CAD traffic stop dataset contained records for the BAC value of the stopped driver. Out of the 932 DUI stops in Franklin County between January 2020 and September 2023, 265 had recorded BACs.

Based on our correspondence with Franklin/Fulton Drug and Alcohol officials, blood draws for BAC occur an average of 1 hour after arrest. According to medical experts, alcohol leaves the body at a rate of 0.015g per hour (University of Toledo, n.d.). Consequently, this means that the recorded BACs are likely lower than the drivers' true BAC at the time of stop. While we did not know true amount of time between arrest and blood draw for the CAD records, we felt that adding 0.015 to the recorded BACs provided a better estimate of the driver's true BAC at the time of stop. Consequently, after removing one outlier (0.92), we graphed the distribution of BACs plus 0.015 with their associated tier of offense in Figure 2.7.

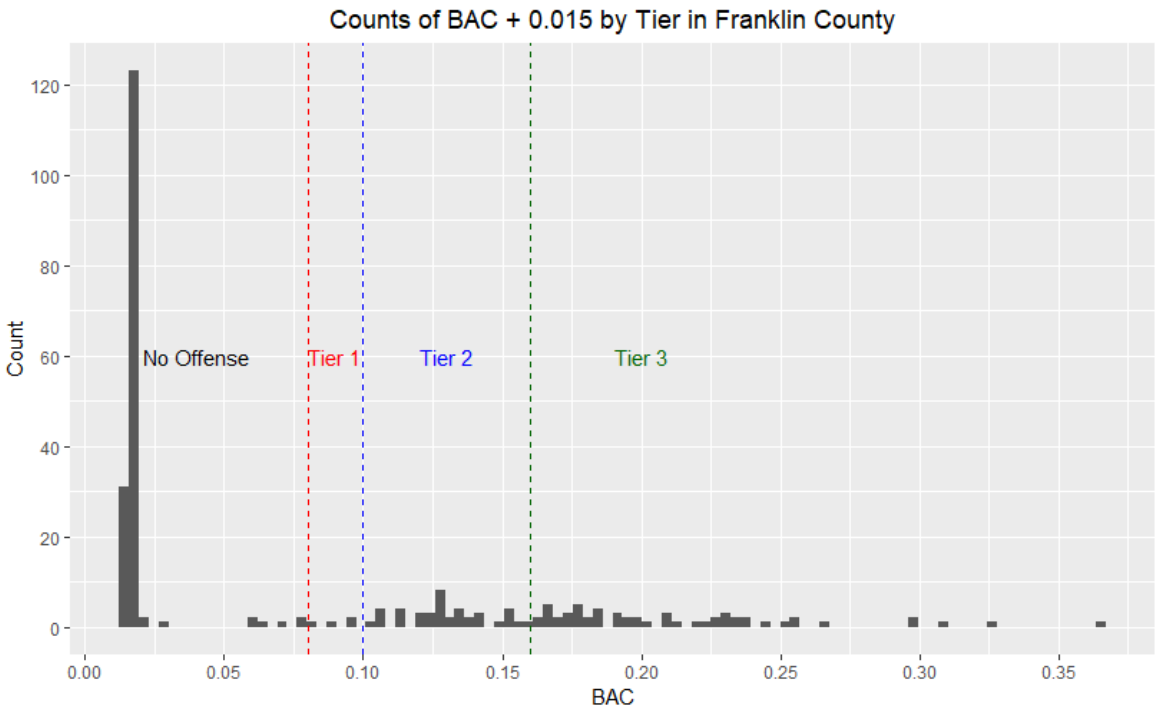


Figure 2.7: *Adjusting for an hour between arrest and blood draw, most recorded BACs were still near 0.0.*

There are several interesting takeaways from Figure 2.7. First, it shows that non-offense level BACs were quite common. Assuming that each BAC was taken one hour after arrest, 58% (154) of BACs were at or below 0.02 at arrest, which is well under the legal limit and roughly corresponds to one drink (University of Toledo, n.d.). There are three possible mechanisms behind this high proportion of low BACs. First, these individuals may tend to drive recklessly, leading to their apprehension and a blood draw regardless of impairment. Second, these individuals may have shown signs of impairment even at the low BAC. Studies have shown that there is no cutoff level for impairment; a BAC as low as 0.015 can cause significantly longer reaction times and impairment in divided attention tasks (Martin et al., 2013). It is possible that impairment began much sooner than at 0.05 for these individuals. Lastly, it is possible that some of these individuals were also under the influence of drugs that caused substantially more impairment than with the BAC alone. In a meta-analysis, Nochajski and Stasiewicz (2006) relayed that in some studies drivers with low BACs were more likely to also be drugged drivers.

There were surprisingly no BACs in the 0.028 to 0.062 range. While this may be a consequence of the small sample size, this gap may also suggest that there exists a population of responsible drivers who do not drive after consuming more than one drink. That is, because there was a large proportion of stopped drivers with low BACs but not stopped drivers with BACs within a 2-4 drink range, we can assume that a good portion of individuals were responsibly choosing not to drive. Otherwise, it is likely that police would have stopped some, whether routinely or for signs of impairment. This may allude to drink-drivers getting “more drunk” than drivers who are not inclined to drink-drive.

Figure 2.8 simply shows the distribution of BACs as tiers. Tier 1 offenses were the least common. In addition to BACs clustering at values over 0.12, tier 1 offenses were rare because it has the narrowest window of all the tiers. The range of tier 1 is just 0.02.

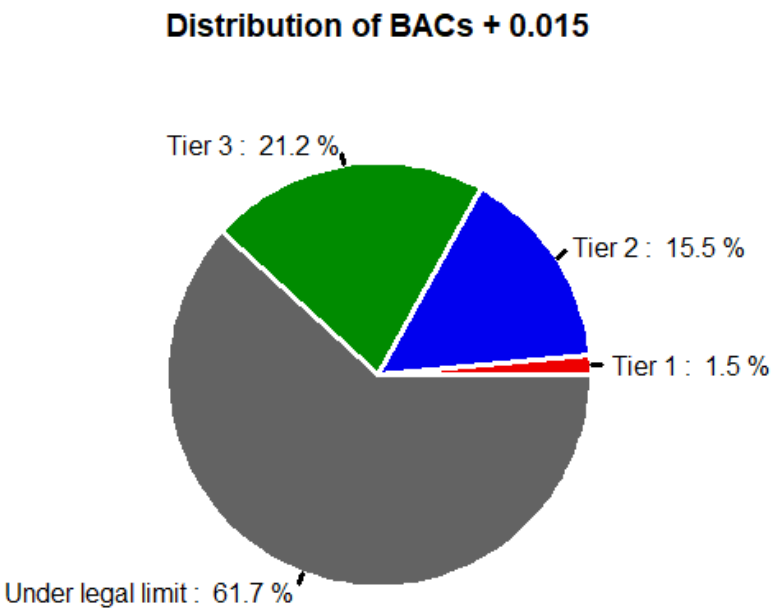


Figure 2.8: *Nearly two-thirds of recorded BACs were below the legal limit, even after adding 0.015 to account for the delay between arrest and blood draw.*

Arrest data came from the CDR reports. Surprisingly, 101 out of 4,680 (1.1%) of all recorded CDRs resulted in an arrest. Fifty of them were DUIs, which means that 96% of the DUI CDRs resulted in arrest.

2f. What was the distribution of substances in DUI traffic stops? What was the prevalence of other charges?

Substance distribution

The CAD records logged the initial and final call types; the final call type specified if the stop was related to DUI. We chart the distribution of substances recorded by the PSP officers in Figure 2.9. Half of the 932 DUI traffic stops concerned only alcohol, and alcohol was involved in combination with drugs in 8% (75) of DUI traffic stops. Recall that in Question 1d we found that alcohol was involved in approximately 79% of DUI crashes.

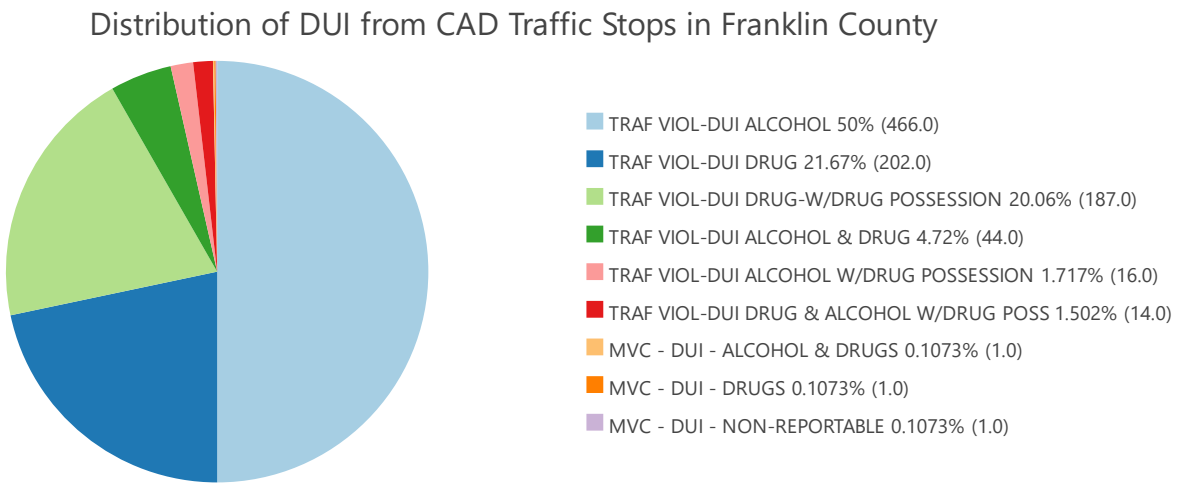


Figure 2.9: *Alcohol DUIs comprised half of DUI traffic stops. MVC stands for motor vehicle crash.*

Charge distribution

The CDR records included the sections and subsections for the specific criminal code violations, allowing us to analyze the relevant substances more precisely. Using offense descriptions from the Pennsylvania Code (214 Pa. Code §303.15), we report the counts and rates of the top 10 charges accompanying the 52 DUI CDR records in Table 2.3. Note that the total is greater than 52 because multiple charges existed for individual cases. Unsurprisingly, careless driving was the most prevalent change accompanying DUI charges. Straying lanes occurred half, supporting the results from Question 1h that DUI crashes were more likely than non-DUI crashes to involve lane departures. Drug paraphernalia and possession charges were also common.

Count	Percentage of cases	Section and Subsection	Charge Description
38	73.1	3714 A	Careless driving
35	67.3	3802 A1	DUI general impairment
28	53.8	780-113 A32	Drug paraphernalia
26	50.0	3309 1	Not driving in a single lane
19	36.5	780-113 A31I	Marijuana - small amount personal use
17	32.7	3802 B	DUI 0.10-0.16 (tier 2)
13	25.0	780-113 A16	Simple possession
12	23.1	3802 D1i	DUI controlled substance sched I
12	23.1	3802 D2	DUI controlled substance
11	21.2	3802 C	DUI >=0.16 (tier 3)
…			

Table 2.3: *The top 10 charges accompanying DUI charges in traffic stops reveal that risky driving behaviors and drug possession are common with DUI offending.*

PART III: DUI SENTENCING AND RECIDIVISM

Research Questions

3a. What were the trends in severity and recidivism in sentenced DUI cases?

3b. What were the demographics of sentenced DUI offenders?

3c. What crimes were frequently committed alongside DUIs?

3d. What did sentencing look like for DUI offenders?

3e. How long were incarceration sentences?

3f. What conditions were imposed on DUI offenders?

Primary Findings

- Tier 3 DUIs were more common than tiers 1 and 2 and made up over half of DUI offenses.
- Alcohol DUI offenses were more likely to be repeat offenses than drug DUI offenses, contrary to prior research. Franklin County may need to investigate focusing its efforts on curbing alcohol dependency problems.
- For every female DUI offender, there were 4 male DUI offenders.
- Male offenders were slightly more likely to be repeat offenders than female offenders.
- Despite having a smaller percentage of people aged 18-24 than the rest of Pennsylvania, Franklin County had a higher percentage of DUIs committed by people in that age range than the rest of the state. This suggests that young people committed DUIs at a higher rate in Franklin County than in other Pennsylvanian counties. The DUIs committed by people aged 18-24 were also more likely than other ranges to have higher-tiered offenses and involve controlled substances.
- The most common charges accompanying DUI charges involved drug possession, but other common charges included reckless endangerment, evading or resisting police, and endangering the welfare of children.
- For charges where the mandatory sentence requires jail time, 42% were sentenced to CIP. This demonstrates that Franklin County judges saw value in rehabilitation programs for some but not all eligible cases. County intermediate punishment (CIP) was more common in alcohol cases than in controlled substance cases,
- Judges imposed CIP in lieu of incarceration in only 55% of alcohol cases. As jail has been shown to be ineffective in curbing recidivism but rehabilitative and substance treatment sanctions have, Franklin County judges should consider increasing the frequency of CIP sentences.

- Predictably, higher-tiered and repeat offenders were issued longer sentences and were more likely to be incarcerated in state facilities.

Methodology and Data

We used the Pennsylvania Commission on Sentencing's datasets from 2017 to 2021. Each dataset contains information on charges sentenced during that year, sans the cases removed by Clean Slate.

Results

3a. What were the trends in severity and recidivism in sentenced DUI cases?

As explained in the Sentencing Data subsection of the Introduction, cases in the sentencing datasets concern all cases that were sentenced within 2017 and 2021, and do not represent all offenses that occurred within those years. Keeping this in mind, Figure 3.1 shows all DUI cases sentenced in Franklin County (purple) and in Pennsylvania (green) from 2017 to 2021. Predictably, both Pennsylvania as a whole and Franklin County saw steep drops in sentenced cases in 2020, but before then both were seeing increases in the number of DUI cases sentenced. These patterns echo those we found in DUI crashes in Question 1a. This reinforces our conclusion that before the pandemic, drunk driving was increasing in Franklin County and Pennsylvania, though there are not enough years present to establish a clear trend in this sentencing data.

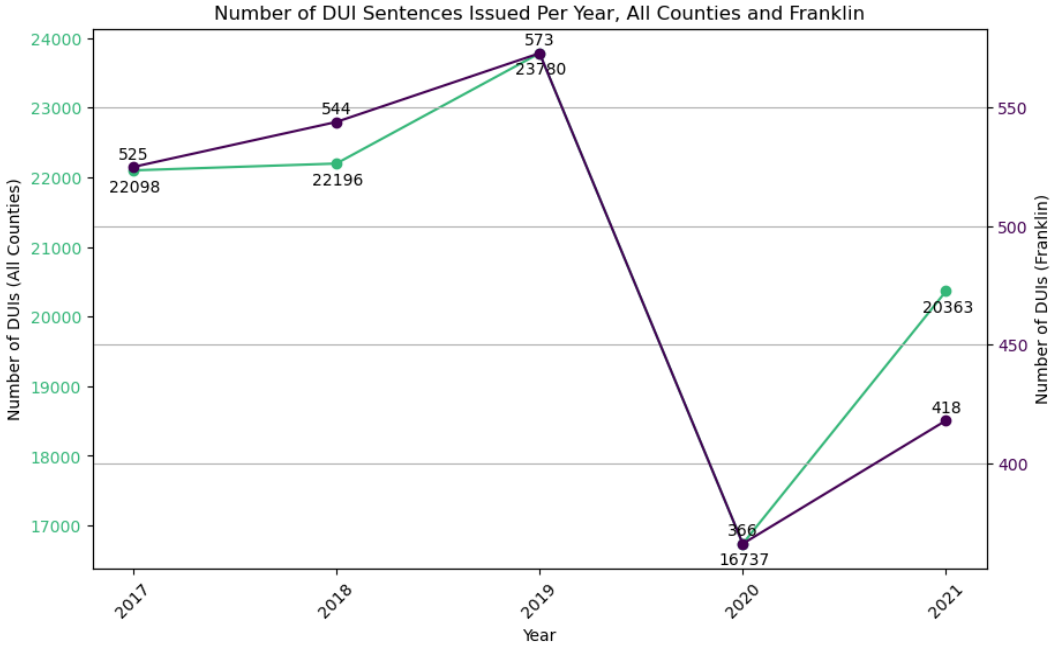


Figure 3.1: *The number of DUIs sentenced in each year in Franklin County and Pennsylvania followed a similar pattern, both peaking in 2019 and dropping significantly in 2020.*

Severity Trends

Figure 3.2 shows the number of DUIs sentenced each year by the tier of offense in Franklin County. Note that this reflects alcohol DUIs only. Over the five years analyzed, the amount of tier 1 DUIs decreased while the amount of tier 2 and tier 3 DUIs stayed approximately the same or decreased slightly. This suggests that not only were DUIs increasing, but the level of intoxication was increasing as well. Note that because of Clean Slate laws, it is possible that many tier 1 offenses and cases are not represented in this data (Administrative Office of Pennsylvania Courts, n.d.). Additionally, tier 3 DUIs also include any driver who refuses a blood test, as any such person is automatically charged with a tier 3 DUI.

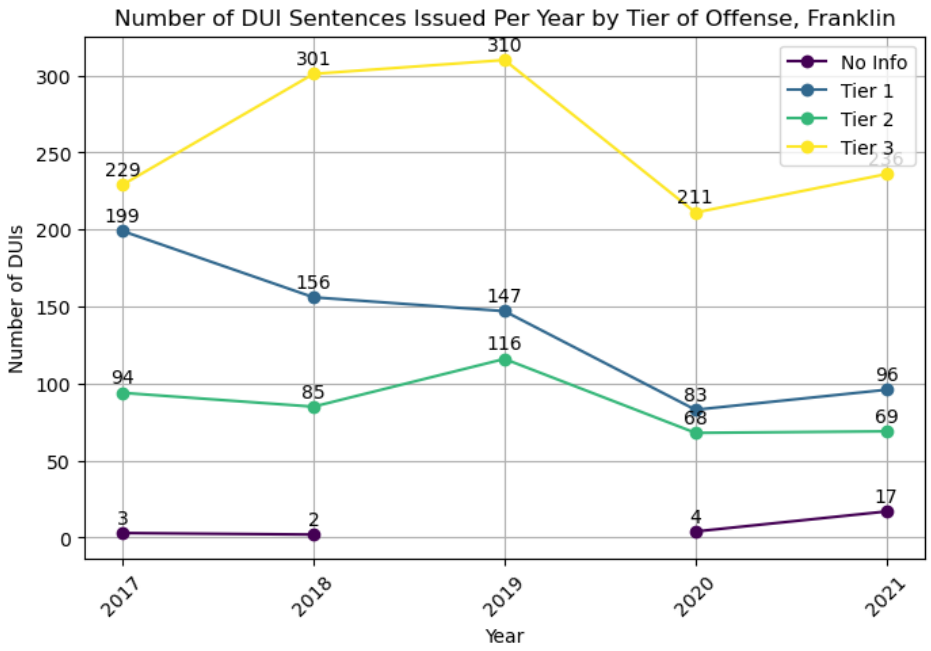


Figure 3.2: *Tier 1 DUIs trended downward; Tier 3 DUIs spiked in 2018 and 2019.*

Recidivism Trends

Figure 3.3 shows the number of DUIs issued in Franklin County in each year by the number of prior DUI offenses (i.e. whether it's the offender's first offense, second, third, or fourth/subsequent offense). The percentage of first-time DUI offenders sentenced in Franklin County had increased slightly before the pandemic, while the percentage of repeat DUI offenders sentenced had decreased overall. The spike in first-time offenders in 2021 supports our conclusion that the pandemic inspired individuals to abuse drugs or alcohol or engage in risky behaviors like DUI when they previous hadn't. Counts for 4th or subsequent offenses are very small, likely in part because a "4th" category does not exist for all types of charges.[6]

[6] For example, *DUI-contr. subst. & incap. safe driving (minor occupant)* has charges for first, second, and third/subsequent offenses. "4th/subsequent offense" only exists for six offenses.

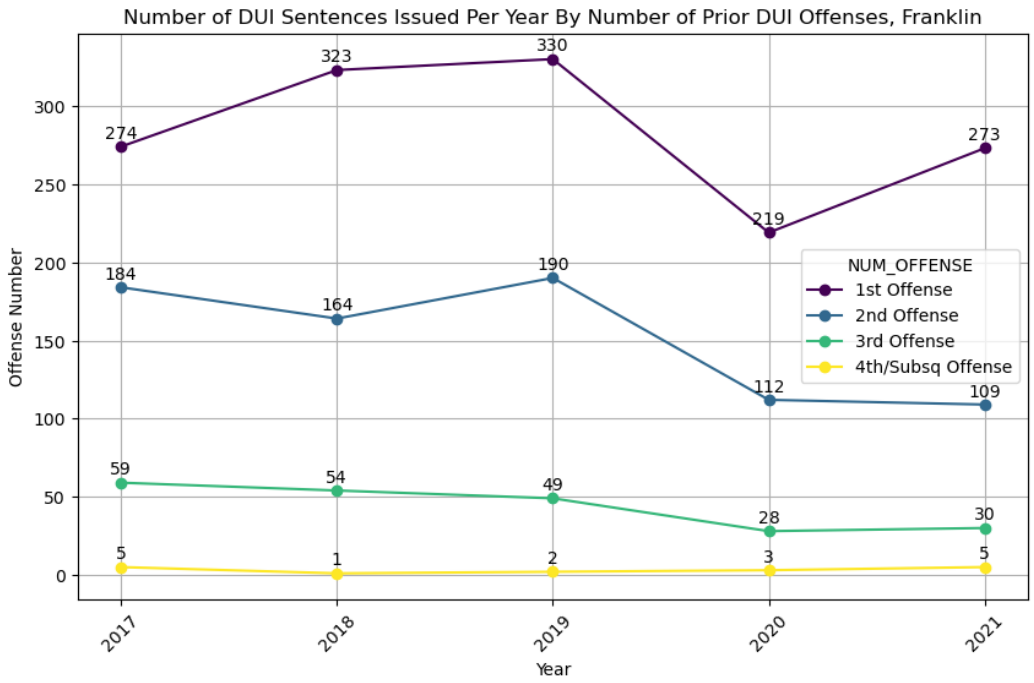


Figure 3.3: *Multiplicity of DUI offense shown by year of sentencing.*

Figure 3.4 examines the recidivism rates by substance and demonstrates that recidivism may vary by the substance used. Nearly half (52%) of alcohol-only DUIs were repeat offenses, while around 35% of controlled-substance-only DUIs and general impairment DUIs were repeat offenses. This suggests that alcoholism or alcohol dependency may contribute to recidivism more than controlled substances in Franklin County. While prior research on DUI recidivism by substance is limited, the studies that do exist find contrary evidence. Impinen et al. (2008) found that drivers convicted of drug DUIs or combination DUIs were significantly more likely to be rearrested than drivers convicted of alcohol-only DUIs. Daimler & Cotton (2019) found that Georgian drivers convicted of opiate DUIs had a greater likelihood of re-offense than alcohol DUIs.[7] Knoth (2015) found that Pennsylvanian drug DUI offenders were more likely than alcohol DUI offenders to recidivate. This suggests that Franklin County's prevention and treatment efforts may need to be directed toward curbing alcohol dependency. More detailed and statistically robust research tracking specific individuals is needed to gain a better understanding of substance use and recidivism patterns in Franklin County.

[7] The researchers also found that drivers convicted of marijuana DUIs had a 21% lower rate of re-offense.

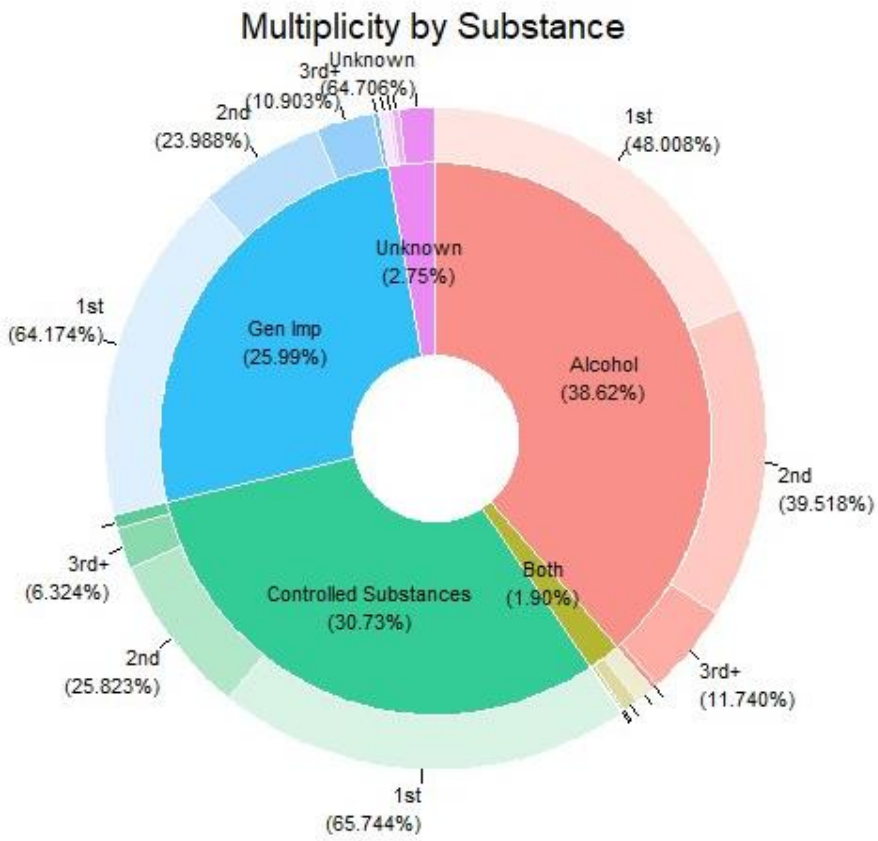


Figure 3.4: *Alcohol DUIs were more likely to be repeat offenses than controlled substance or general impairment DUIs. The darkest shades on the outside donut represent charges of unknown multiplicity.*

3b. What were the demographics of sentenced DUI offenders?

Gender

Figure 3.5 shows that DUIs in Franklin County were overwhelmingly committed by men, who made up 78.4% of DUI offenses. This is largely similar to Pennsylvania, where 77.2% of DUI offenses were committed by men. Even though a large percentage of DUIs in Franklin County were committed by male offenders, a slight majority of adults in the county are female. Franklin is also, in this regard, demographically similar to the rest of the state, where 48.9% of people are male. Both regions show that men were sentenced to DUIs at a rate that is much higher than the percentage of the population that they make up. However, there is no evidence to suggest that the propensity for men to commit DUIs at a high rate is limited to Franklin County or Pennsylvania. As discussed in Part II, many diverse studies have confirmed that men are much more likely to drive while intoxicated than women.

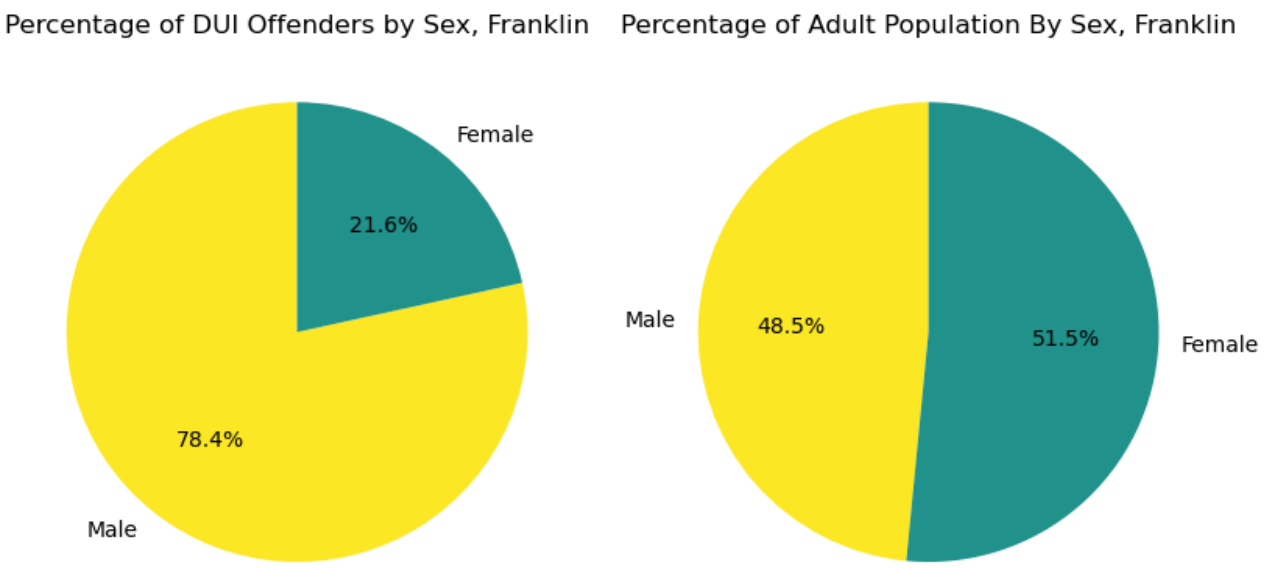


Figure 3.5: *A majority of DUIs in Franklin County were committed by men.*

However, less research has been done on the disparities between men and women in the characteristics of their DUI. Here, we investigated disparities in DUI offenses between men and women. Figure 3.6 plots the proportions of DUI tiers by each reported sex. The proportions are nearly identical, suggesting that Franklin County women and men had similar patterns of alcohol use when committing DUIs.

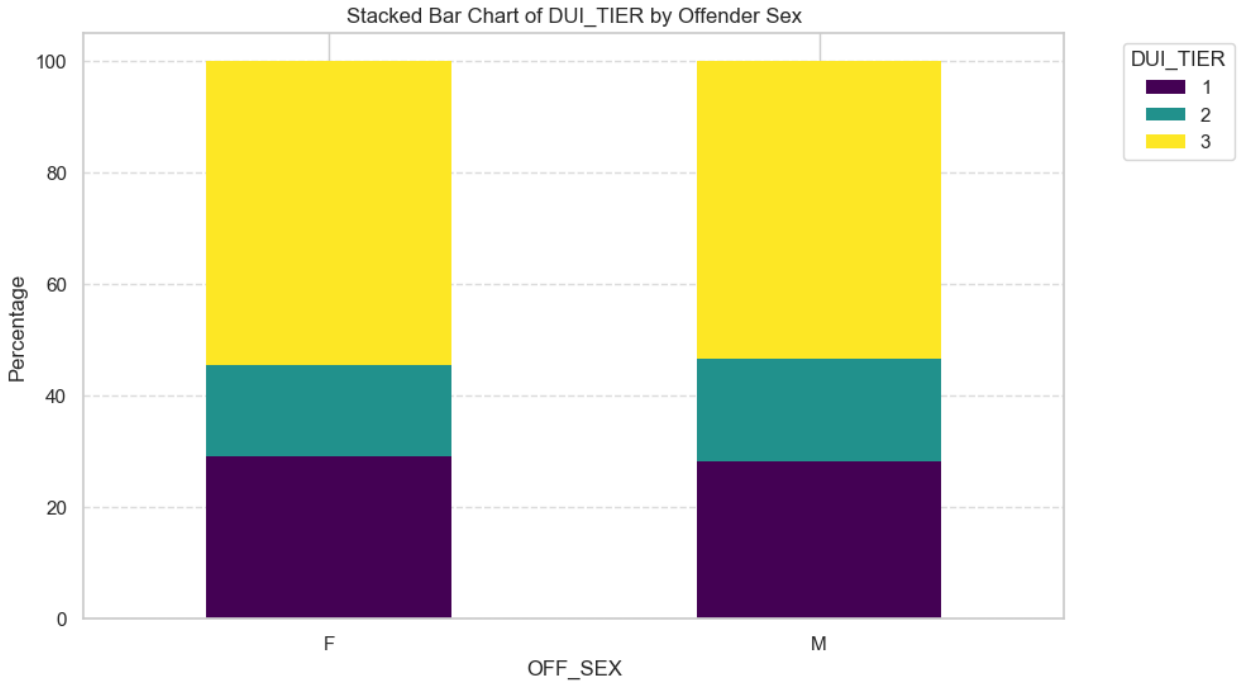


Figure 3.6: *Women and men convicted of DUIs had nearly identical proportions of tiered offenses.*

Figure 3.7 does the same for recidivist offenders. Males were slightly more likely to be repeat DUI offenders than women; around 61% of female cases were first-time offenses, while 56% of male cases were first-time offenses. While this agrees with other research, prior work found that males are much more likely to recidivate on DUI than females (Knoth, 2015; Impinen et al., 2009; Lapham et al., 2006; Nochajski & Stasiewicz, 2006). This suggests that females in Franklin County, while making up less than a quarter of DUI cases, may be more likely to recidivate in Franklin County than in other regions, as Franklin's data did not show the same large discrepancy as other research. Research that tracks individuals is needed to support this.

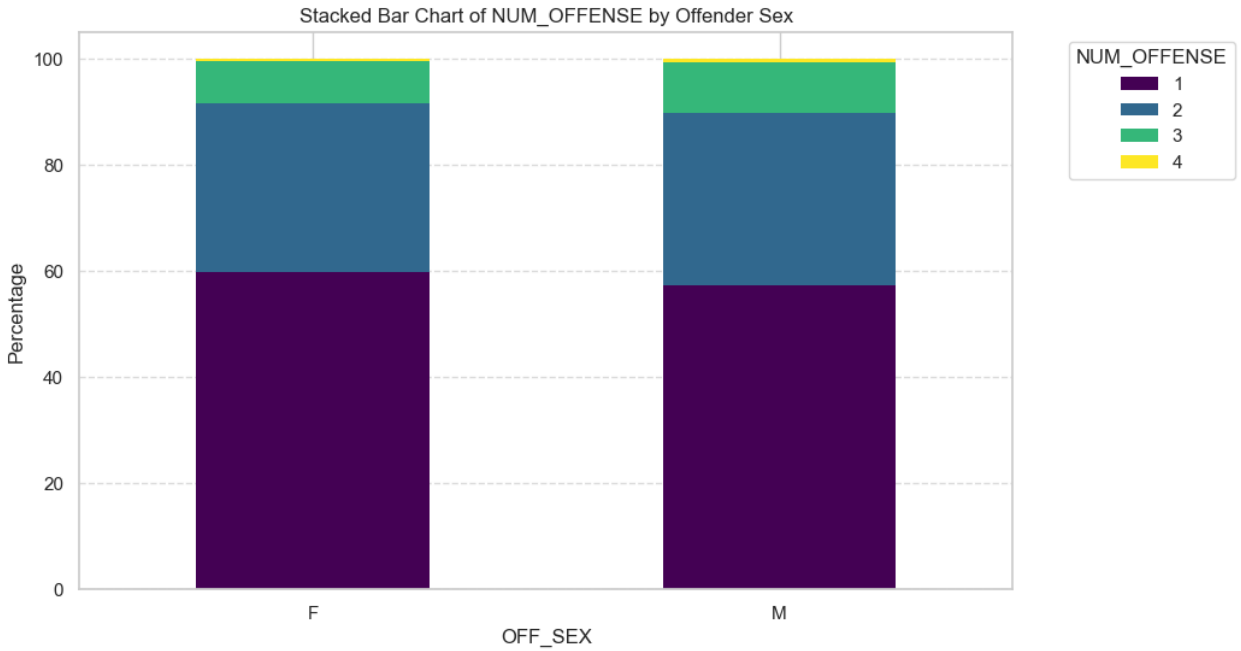


Figure 3.7: *Females were slightly less likely than males to be DUI recidivists.*

Figure 3.8 investigates if substance use differed between male and female DUI offenders. Female offenders were slightly more likely to have used controlled substances than males when committing DUIs – 33% of female DUIs regarded controlled substances while 30% of male DUI regarded controlled substances. While research investigating substance use patterns in gender is limited, some work has found that males convicted of DUIs were slightly more likely to be alcohol dependent, and females were more likely to have drug dependence (Maxwell & Freeman, 2007).

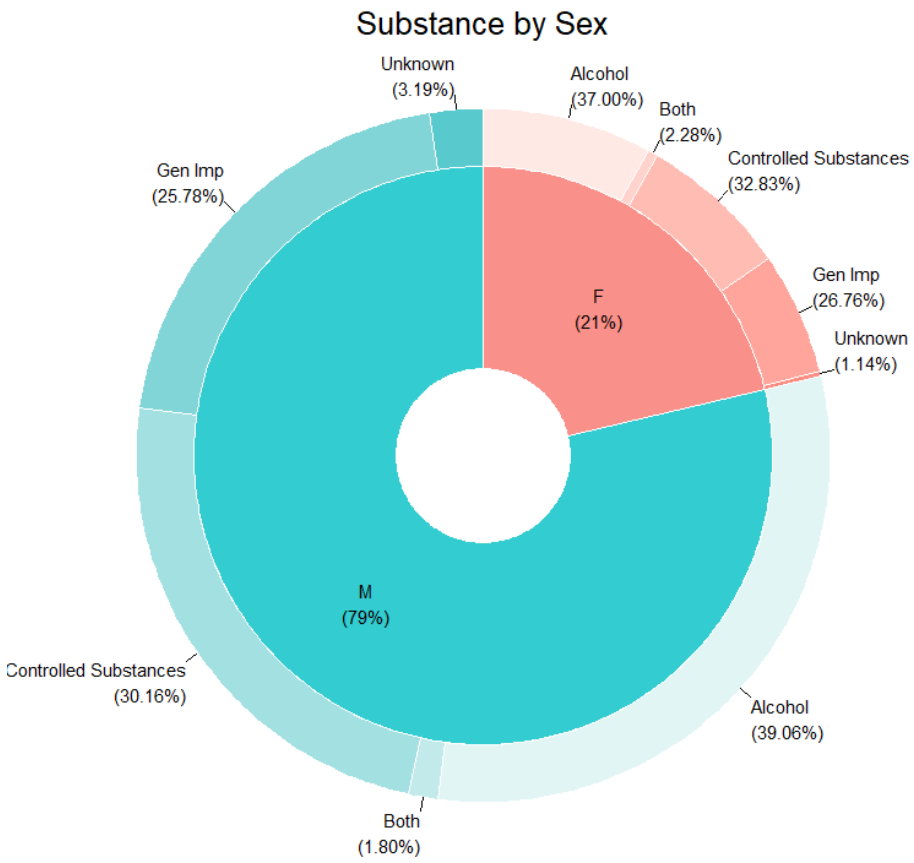


Figure 3.8: *Controlled substances were more prevalent in female DUI cases, while alcohol was more prevalent in male DUI cases.*

Age

Figure 3.9 shows the distribution of ages of DUI offenders in Franklin County and in Pennsylvania. The age distribution of Pennsylvania closely echoes those of prior Pennsylvania research (Knoth, 2015). The mean age of offenders in Franklin is 35.79, slightly younger than the mean age of offenders in all of Pennsylvania, which is 37.10. The histograms visually hint that Franklin County has a higher percentage of DUIs coming from people under or around the age of 20 than the state. Our further analyses strongly support this claim.

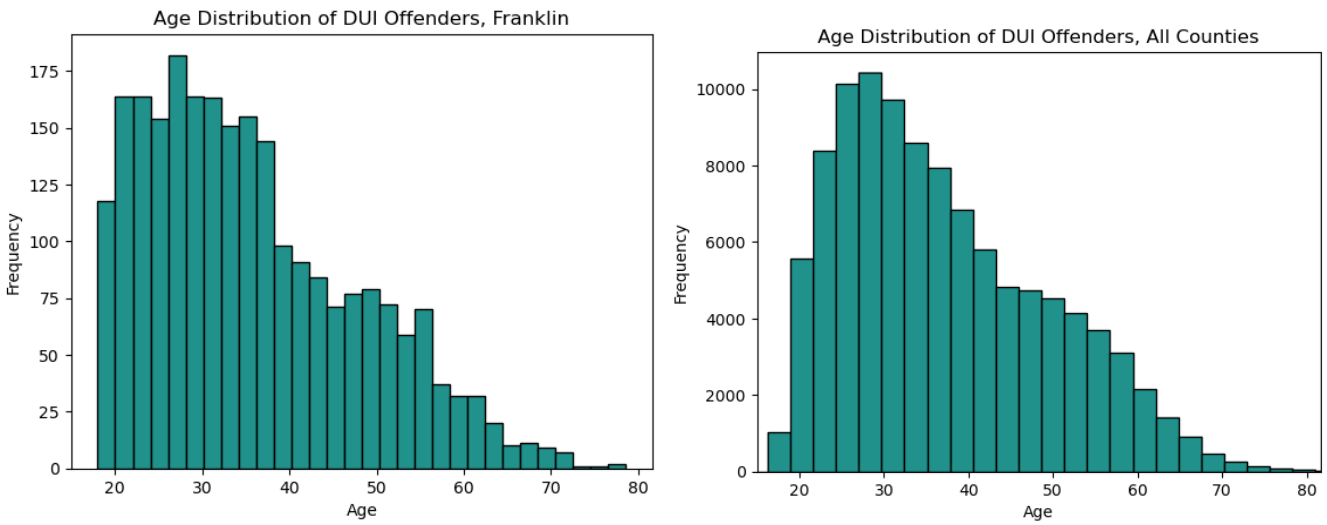


Figure 3.9: *The distribution of DUI offender ages was similar to the distribution for Pennsylvania, but Franklin County seems to have a larger proportion of DUIs committed by people 25 and younger.*

Figure 3.10 supports the prior supposition that while young people have been shown to be prone to DUI, they may make up a greater share of DUIs in Franklin County than in Pennsylvania, particularly in the 18-24 age bracket. The percentages of DUIs committed by people 18-24 was 5 percentage points higher in Franklin County than in Pennsylvania. To investigate if this difference originates from the population of Franklin County, we referenced demographic data from the United States Census Bureau (U.S. Census Bureau, 2021). Figure 3.10 also shows the percentage of adults in Pennsylvania that are between the ages of 18-24 in Franklin County and Pennsylvania compared to the percentage of DUIs committed by people in that same age range. Franklin County had a smaller percentage of people aged 18-24 than Pennsylvania, but a higher percentage of DUIs sentenced in the county that result from that population. This strongly suggests that Franklin County has a disproportionate percentage of young people driving intoxicated as opposed to rates observed elsewhere. Resources for DUI prevention efforts in Franklin County may need to be directed toward young people, particularly those aged 18-24.

Crossing other variables with age reveals more about the DUI habits of different groups. DUIs committed by younger people were more likely to be higher-tiered offenses than those committed by older people, as shown in Figure 3.11. DUIs committed by people 18-19 and 20-24 years old were much more likely to be tier 3 offenses than DUIs committed by people in any other age group. Not only were young people in Franklin County committing DUIs at a high rate, but they were also committing DUIs of higher severity than other age groups.

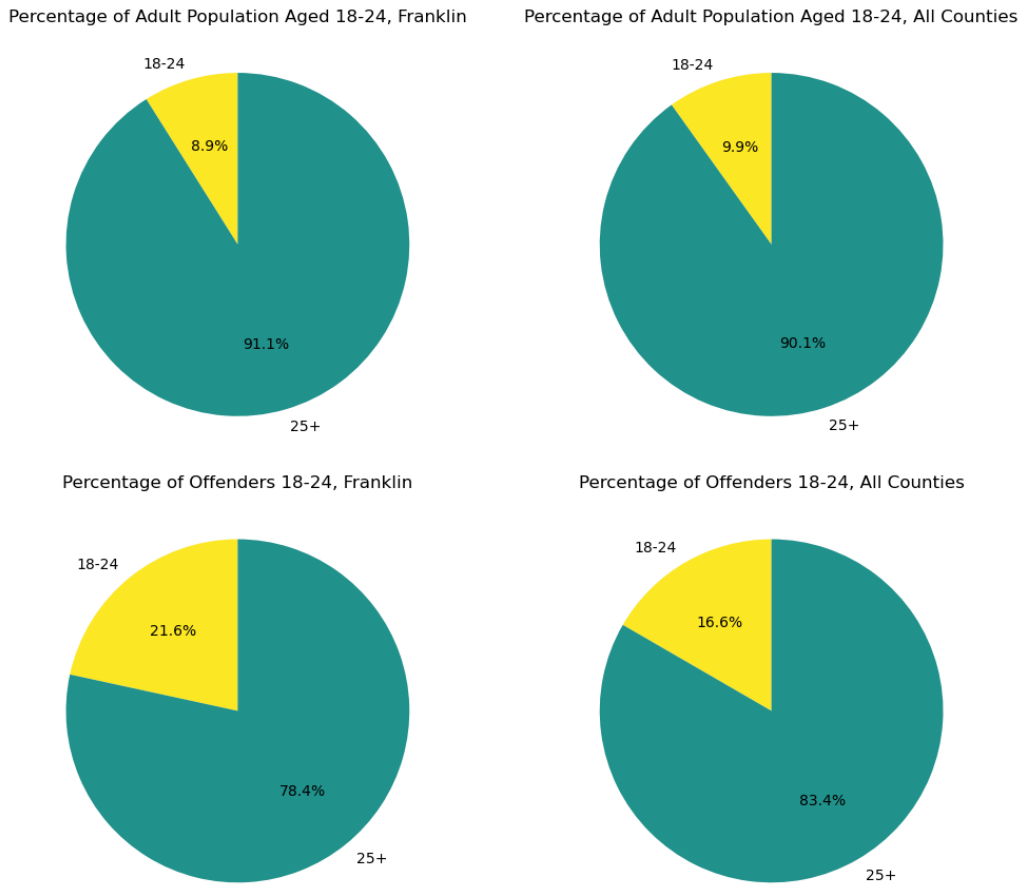


Figure 3.10: *Despite making up a smaller percentage of the adult population, 18-24 year-olds make up a larger percentage of DUI offenders in Franklin than in the rest of the state.*

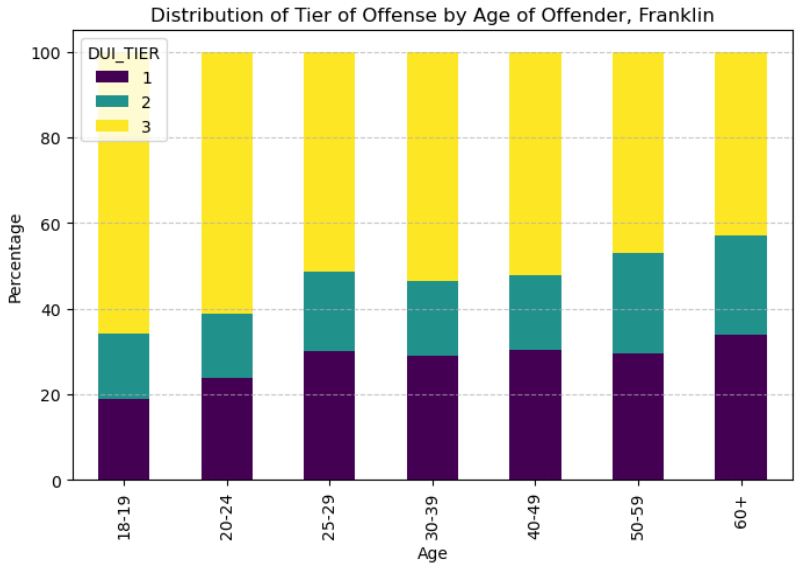


Figure 3.11: *DUIs committed by young people were more likely to be Tier 3 offenses than those committed by people in older age groups.*

There was significant variation in the drugs used by the age groups. Figure 3.12 shows the percentage of DUI cases by substance for each offender age group. General impairment DUIs or DUIs without an indicated substance are labeled “No Data”. Figure 3.12 shows that a higher percentage of DUIs committed by young people involved controlled substances whereas DUIs committed by older people were more likely to involve alcohol. This, combined with Figure 3.10, suggests that prevention efforts may need to be increased to deter young men from driving under the influence of controlled substances.

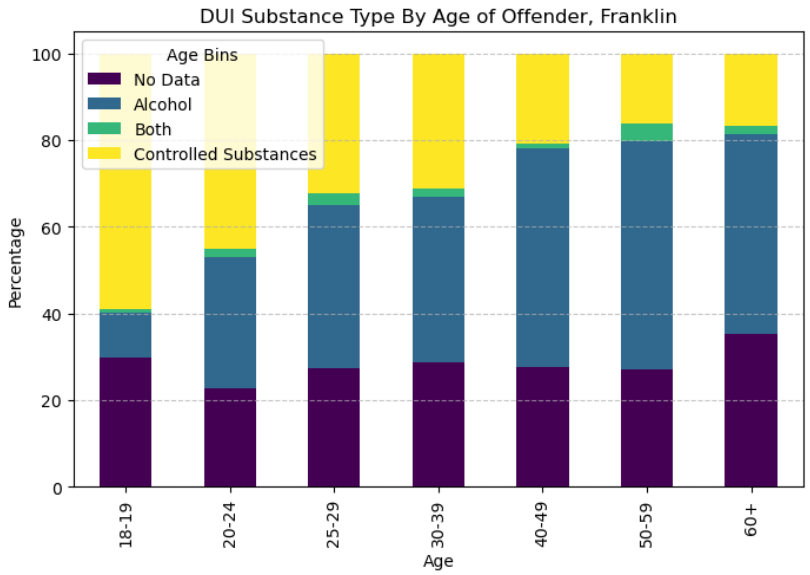


Figure 3.12: *As the offender’s age increased, so did the likelihood of alcohol being the DUI substance as opposed to controlled substances.*

Investigating recidivism by age group, Figure 3.13 shows the proportions of offense multiplicity by age group. Intuitively, a higher proportion of drivers aged 18-19 were convicted of first-time offenses than those proportions from other age groups.

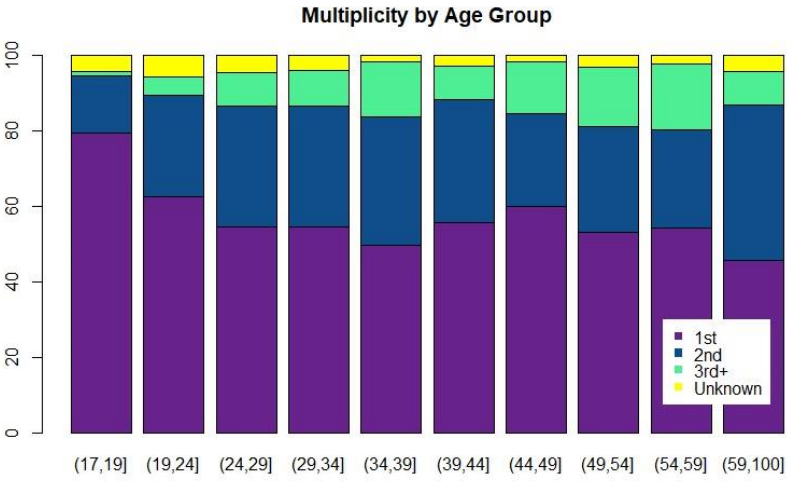


Figure 3.13: *Drivers 24 years old or younger tend to have more first-time offenses than older drivers.*

3c. What crimes were frequently committed alongside DUIs?

People are often convicted of multiple crimes at once, so to get a more complete picture of a DUI occurrence in Franklin County we examined the charges frequently issued to individuals alongside DUIs. Table 3.1 shows the non-DUI offenses that most frequently occurred alongside DUI offenses. Confounding charges that occurred five or fewer times are excluded. It is important to note that these convictions likely do not reflect the full charges issued to defendants upon arrest due to plea bargaining.

Unsurprisingly, the most common offenses accompanying DUI charges involve drug possession. However, other common offenses include reckless endangerment of another person and endangering the welfare of children. These charges indicate that some intoxicated drivers were putting passengers at risk in addition to themselves. Other common charges are related to evading or resisting arrest. It is worth noting that, especially towards the bottom of the table, the offense labels have very few occurrences. This is because many DUI cases do not involve confounding charges.

Accompanying Charge	**Frequency**
Possession – drug paraphernalia	86
Recklessly endangering another person	39
Fleeing or eluding police officer – with: DUI	37
Simple possession (1st off)	35
Endangering welfare of children – violate duty of care	29
Resisting arrest	19
Fleeing or eluding police officer	15
Accident involving damage to attended vehicle or property	14
Possession – small amt of marijuana (<=30g) personal use	11
Simple assault – attempt/case BI	10
Possession with intent to deliver – marijuana (<1 lb)	9
Illegally operating motor vehicle not equipped with ignition interlock – BAC >=0.025	7
False identification to law enforcement authorities	6
Disorderly conduct – frightening/threatening behavior (substantial harm/persist after warning)	6
Drive w/ suspended license & BAC >= 0,02% /or under influence of controlled substance (2nd off)	6

Table 3.1: *The most common types of offenses that were sentenced alongside DUIs were related to drug possession.*

3d. What did sentencing look like for DUI offenders?

Guideline departures and County Intermediate Punishment

When sentencing a convicted individual, judges generally make two decisions: (1) the type of punishment to impose, whether prison, jail, probation, or restorative sanctions, and (2) the duration of the punishment. Judges usually impose a sentence minimum and maximum, where the minimum is the shortest length of time the individual is required to serve before they are eligible for parole. If the individual never receives parole, they serve the maximum sentence imposed by the judge.

Judges have decent discretion in deciding what sentence to impose (Kramer & Ulmer, 1996), though there are some constraints. For some charges, like DUIs, mandatory minimums limit the minimum sentence judges can impose. DUI mandatory minimums range from 2 days to 12 months of incarceration. Similarly, statutory maximums limit the maximum sentence a judge can impose. In addition to these constraints, the PCS provides sentencing guidelines that judges are recommended to follow. For each charge, the Sentencing Guidelines recommend a sentence type and a range of appropriate sentence minimums determined by the offense's severity and the offender's criminal history.

One of the ways Pennsylvanian sentencing practices are often analyzed is through guideline departures, which occur when judges impose sentences that deviate from the guideline recommendations. This can occur in four ways, as summarized in Table 3.2. Essentially, dispositional departures occur when a judge imposes a sentence type that disagrees with what the guidelines recommend; durational departures occur when a judge imposes a sentence that matches the recommended type but is longer or shorter than what the guidelines recommend. Departures can be favorable or unfavorable for the defendant.

Departure Type	Description	Example
Downward Dispositional	A non-carceral sentence is imposed when the guidelines recommend carceral sanctions.	A judge sentences probation for an offense that the guidelines recommend incarceration for.
Upward Dispositional	A carceral sentence is imposed when the guidelines recommend non-carceral sanctions.	A judge sentences incarceration for an offense that the guidelines recommend probation for.
Downward Durational	A carceral sentence with a minimum term shorter than the guidelines recommendation is imposed.	A judge sentences 2 months in jail for an offense that the guidelines recommend at least 3 months for.
Upward Durational	A carceral sentence with a minimum term longer than the guidelines recommendation is imposed.	A judge sentences 4 months in jail for an offense that the guidelines recommend at least 3 months for.

Table 3.2: *Different types of sentencing guideline departures.*

When analyzing sentencing patterns, it is important to consider the role that these constraints play. First, studying departures can yield insight into the perceptions of judges on certain charges. For example, if judges consistently sentence certain crimes lower than the guidelines' recommendation or near

mandatory minimums, then judges may generally feel that recommended or enforced sanctions are too strict, harsh, or inappropriate for those crimes (Wrigley & Schumacher, 2023).

Second, it can help explain recidivism patterns. Several works have been published that analyze the incapacitating and deterring effects of different sanctions on rearrests and reconvictions. Carceral sentences incapacitate DUI offenders in the immediate period following the offense, but there is little evidence that this effect continues post-incarceration (Rahman & Weatherburn, 2021). Some found that punishment certainty – the certainty of jail time, fines, and other justice sanctions – was related to a lower risk of offending (Bouffard, Niebuhr, and Exum, 2017; Stringer, 2021), but this deterrence effect is not consistent throughout the population of DUI offenders or the country. Stringer (2021) found that perceptions of punishment certainty differed among problem and non-problem drinkers. He found that problem drinkers had higher punishment certainty, but were more likely to engage in DUI, suggesting that the certainty of punishment did not deter these individuals. Similarly, Bouffard, Niebuhr, and Exum (2017) found no evidence that actual experience with carceral DUI sanctions increased punishment certainty or impacted DUI intentions. More broadly, Wagenaar et al. (2007) investigated the deterring effects of new laws establishing mandatory minimum fines or jail sentences in 26 states and determined that these mandatory sentences decreased DUI-related deaths in six states, but 17 showed no significant change (including Pennsylvania) and three showed significant increases. Consequently, examining rates of incarceration versus other sanctions explores potential opportunities to better understand DUI offending and recidivism rates.

The mandatory minimum sentences set by law are reproduced in Table 3.3 (75 Pa. Code § 3804).

Charge	**Mandatory Minimum 1st Offense**	**Mandatory Minimum 2nd Offense**	**Mandatory Minimum 3rd Offense**
All charges listed below	• Attend highway safety school • Comply with drug and alcohol treatment (if any)	• Attend highway safety school • Comply with drug and alcohol treatment (if any)	• Comply with drug and alcohol treatment (if any)
General Impairment; BAC 0.08-<0.10	• 6 months probation	• 5 days incarceration	• 10 days incarceration
BAC 0.10-<0.16; minors; commercial vehicles, school buses and school vehicles; accidents	• 2 days incarceration	• 30 days incarceration	• 90 days incarceration
Incapacity; BAC >=0.16; controlled substances	• 3 days incarceration	• 90 days incarceration	• 1 year incarceration

Table 3.3: *DUI charges and their mandatory minimums. Mandatory fines, other restitutions, and 4th/subsequent offenses are not included.*

Figure 3.14 shows the distribution of departures by the top 21 DUI offenses. We did not label cases sentenced to CIP or SIP as dispositional departures because they are permissible by law in lieu of incarceration (204 Pa. Code § 303.12(a4v)). If the court sentences an eligible DUI offender to CIP, they are either assigned to a residential inpatient drug and alcohol rehabilitation program or they are assigned a

combination of house arrest, electronic monitoring, and drug and alcohol treatment (37 Pa. Code § 451.52(b)). As these sanctions are quite distinct, in Figure 3.12 we differentiated cases sentenced to CIP only as opposed to the recommended incarceration in green.

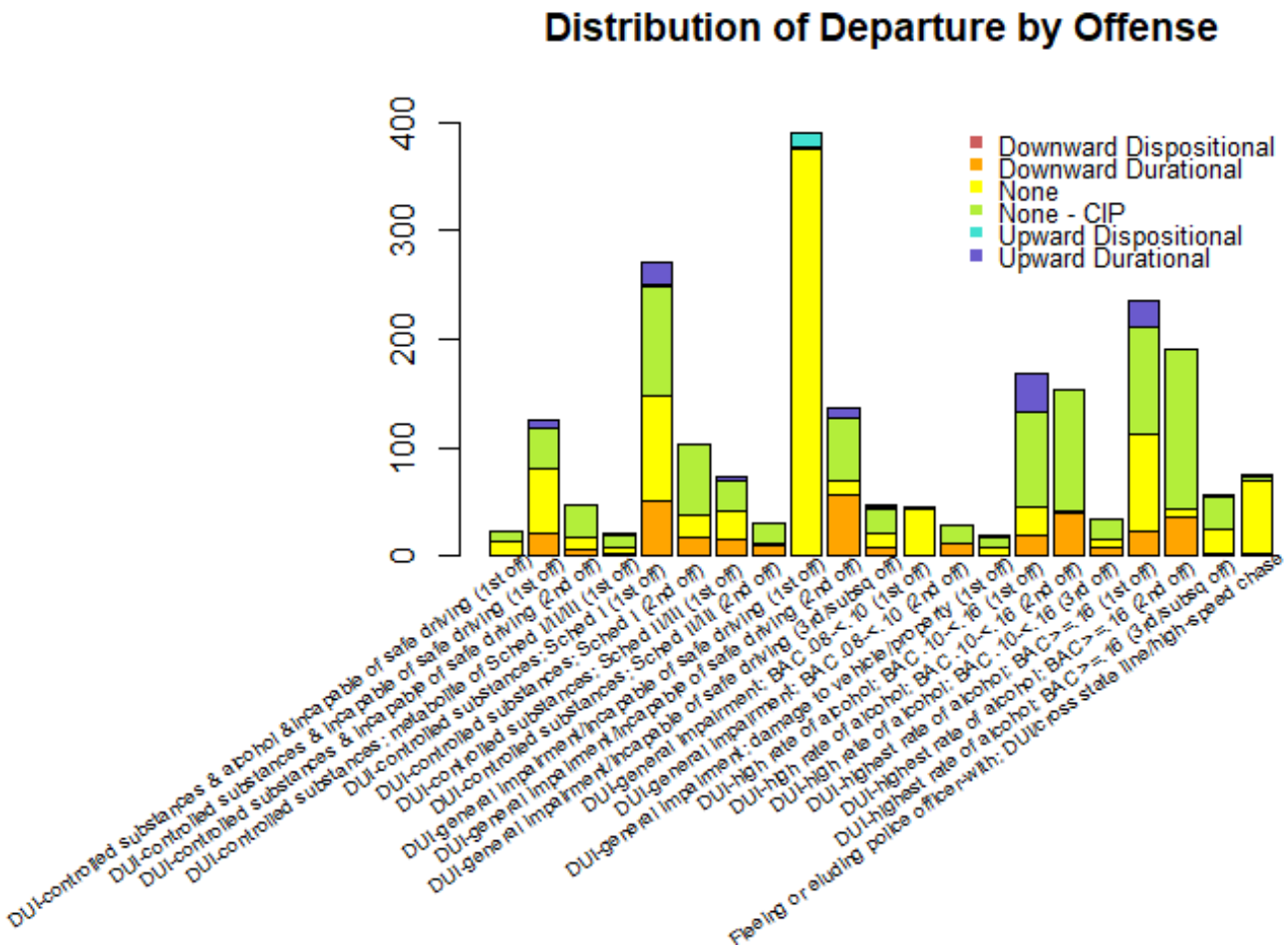


Figure 3.14: *There was substantial variability in the application of CIP to DUI offenses.*

The most common DUI offense, a first offense general impairment, was mostly sentenced to the mandatory minimum requirement of 6 months' probation. None of the reviewed cases were sentenced to probation terms longer than 6 months. Less than 4% of charges were given jail sentences as opposed to the mandatory probation term, as shown by the light blue bar representing upward dispositional departures. Sentencing of these cases appears standard, with judges following the mandatory minimum in 96% of cases. Similar patterns appear in "DUI-general impairment; BAC 0.08-<0.10", which is the other charge with a mandatory 6 months of probation. These two charges as well as "Fleeing or eluding police officer-with: DUI" had the least variation in sentencing; almost all sentences for these cases did not deviate from the mandatory minimum or guideline recommendations.

All other charges had substantial variability in sentencing patterns. In 40% of charges, judges utilized CIP as opposed to the traditional incarceration recommended by the guidelines. Of the 2,408 offenses that were eligible for CIP, 1,017 (42%) received CIP. This demonstrates that Franklin County judges saw value in rehabilitation programs as opposed to incarceration in some but not all eligible cases. However, judges

ordered outpatient treatment services in tandem with 96% of incarceration sentences, so they believed incarceration with treatment was necessary in many cases.

Downward durational departures were common, occurring in 15% of charges. This means that judges imposed shorter incarceration sentences than the PCS recommended (but not shorter than the mandatory minimum) 15% of the time. Upward durational departures were rarer – less than 5% of incarceration sentences were longer than recommended. Dispositional departures were the rarest because most DUI convictions are mandated to result in some carceral sentence, prohibiting probation.

Importantly, CIP was more common in alcohol cases (55%) than in controlled substance cases (40%). This is likely because controlled substance DUIs have harsher sentences than tier 1 or tier 2 alcohol DUIs (see Table 3.3). As alcohol DUIs had substantially more repeat offenses, which is likely indicative of alcohol dependency or use disorders, CIP is a more apt response than jail, which has little to no evidence of curbing DUI intentions or recidivism for repeat offenders (Bouffard, Niebuhr, & Exum, 2017; Rahman & Weatherburn, 2021; Schaffer et al., 2007; Stringer, 2021; Wagenaar et al., 2007). Other rehabilitative or substance treatment sanctions have been shown to be effective at reducing DUI recidivism stemming from substance use issues more consistently (Delaney et al., 2004; Miller et al., 2015; Moore et al., 2008).

Incarceration by multiplicity

DUI convictions can result in incarceration in a county facility or a state facility. In Franklin County, in the five years we studied, around 57.5% of cases involving DUIs ended with no incarceration (either CIP or probation), 35.1% went to county facilities, and 7.4% to state facilities. Figure 3.15 shows the proportions of incarceration sentences by offense multiplicity. Incarceration in state facilities was much more common for multiple-time offenders. First-time DUI offenses led to incarceration in state facilities around 2.5% of the time, but this number increased to 36.0% for third or subsequent offenses. While harsher sanctions for repeat offenses are logical on the surface, prior research has found that repeat DUI offenders are more likely to have underlying mental health or substance use disorders that render jail time ineffective at curbing recidivism (Schaffer et al., 2007).

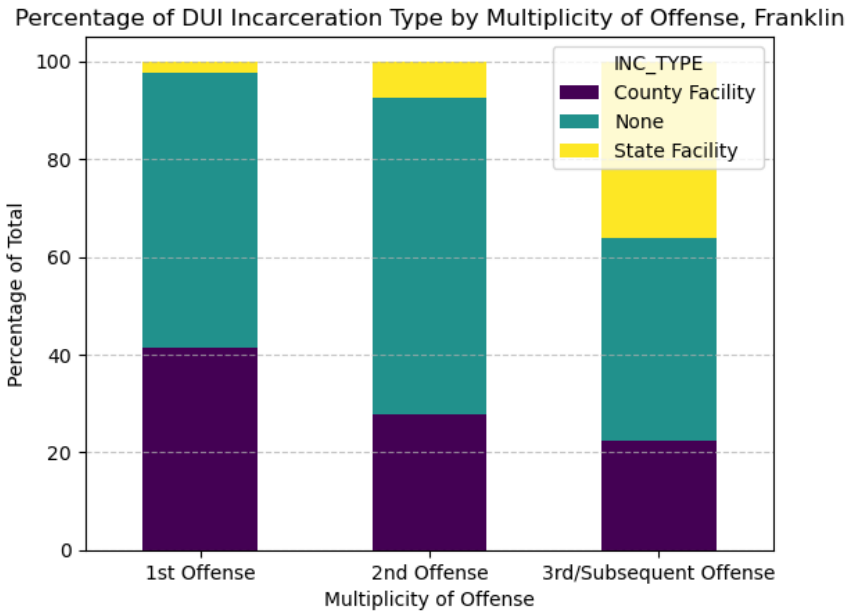


Figure 3.15: *Repeat offenses were much more likely to be incarcerated in state facilities.*

Incarceration by substance

Figure 3.16 graphs the distribution of incarceration type by the substance used. Despite controlled substance DUIs being more commonly first offenses than alcohol DUIs (see Figure 3.4), they were most likely to result in the offender receiving incarceration at a state facility than any other substance. That is, controlled substance DUIs had the lowest recidivism rate and the highest prison incarceration rate.

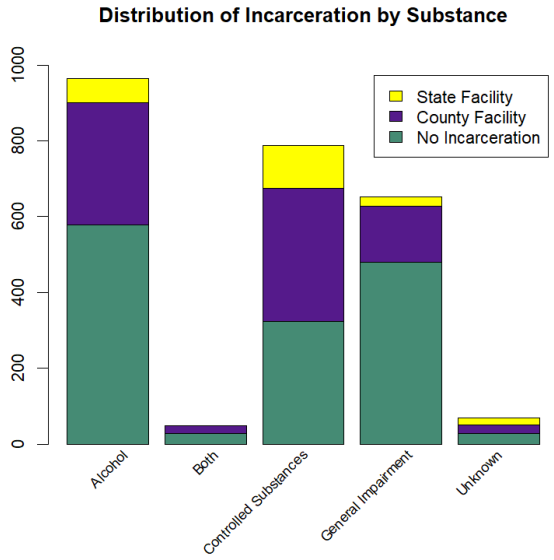


Figure 3.16: *Controlled substance DUIs had the highest incarceration rate of known substances.*

Incarceration by tier

As shown in Figure 3.17, higher-tiered offenses were more likely to result in incarceration than lower-tiered offenses, although the increase was smaller than that of offense multiplicity. Tier 1 DUI offenses led to incarceration in state facilities around 3.2% of the time, but this number increased to 9.5% for third or subsequent offenses. Tier 1 offenses led to incarceration in county facilities 22.0% of the time compared to 35.9% for tier 2 and 42.3% for tier 3. It was rare for tier 1 offenders to receive state facility incarceration.

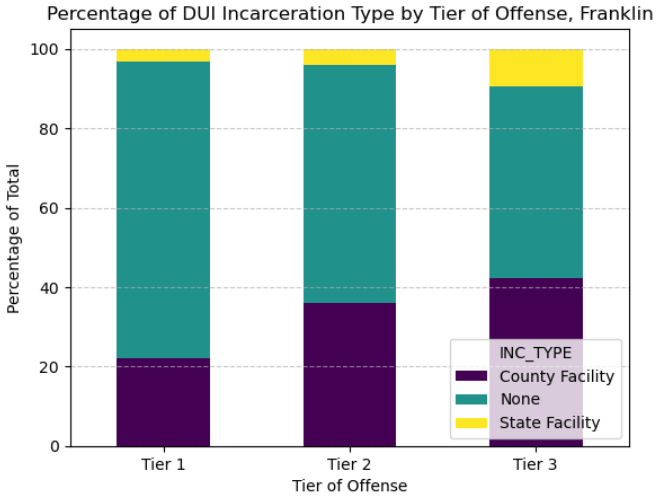


Figure 3.17: *Tier of DUI offense had a smaller impact on incarceration type than multiplicity of offense.*

3e. How long were incarceration sentences?

Departures estimate judges' conformity to the state's assessment of punishment severity, but examining the actual sentence lengths imposed can illuminate more about the nature of the departures. In this question, we analyzed incarceration rates broadly to find overall patterns in sentencing. We examined both the minimum and maximum sentences, as the minimum is the amount of time that the individual is required to serve but can end up serving the maximum if they never qualify for parole. Aggregating outcomes also made comparisons to state sentencing outcomes more intuitive.

Minimum incarceration sentences

To understand minimum incarceration sentences in Franklin County and Pennsylvania, we sought to examine the frequency of judges sentencing the mandatory minimum of incarceration and how frequently they deviated from the mandatory minimum. Judges could use CIP or a combination of CIP and incarceration to fulfill the mandatory minimum requirement, so we compared the mandatory minimum to the sum of the imposed CIP time and any incarceration time. It is worthwhile to note that this never occurred for Franklin County in our dataset, but it did in almost two-thirds of Pennsylvanian counties, though it was rare in most. If an offense was only sentenced to CIP, it was still included in this analysis. If the mandatory minimum and the sum of CIP and incarceration times were within 1 day of each other, they were considered equal. Offenses with mandatory minimum probation terms were excluded here.

Figure 3.18 shows the distribution of how carceral sentence durations plus the imposed CIP time relate to the offenses' mandatory minimum. Interestingly, both Franklin County judges and Pennsylvania judges imposed carceral sentences that were below the mandatory minimum in a non-negligible proportion of offenses. About 10% of Pennsylvania DUI offenses were sentenced to carceral or CIP sentences that were below the mandatory minimum; in Franklin County, this was 6%. These proportions seem large enough to not be the result of clerical error.

Franklin County also imposed a greater share of offenses to carceral/CIP sentences that were above the mandatory minimum than Pennsylvania as a whole: about 42% to 36% respectively. This suggests that Franklin County was more likely to impose longer sentences than the rest of the state. It is possible that this is associated with Franklin County's higher recidivism rate for alcohol than that of prior research. Delaney et al. (2004) found that the length of a strict jail sentence with no treatment was unrelated to the likelihood of recidivism. They also found that the group least likely to recidivate was those sentenced to a combination of jail and treatment.

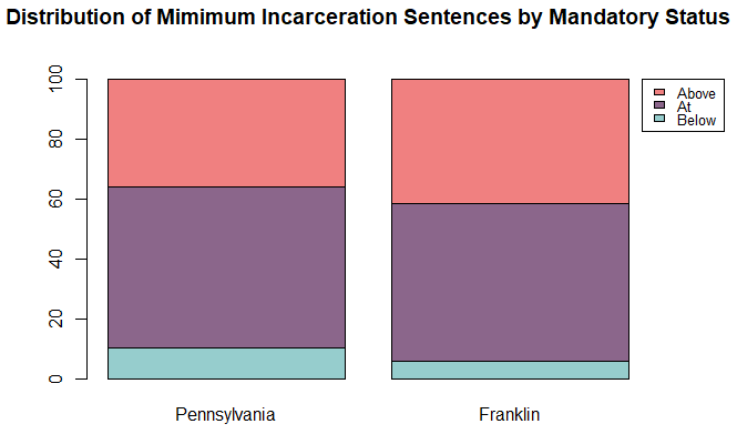


Figure 3.18: *Franklin County tended to sentence DUI offenses above the mandatory minimum more frequently than the state.*

Figures 3.19 and 3.20 plot the distribution of the lengths of time above the mandatory minimum that were set by Franklin County judges and judges across Pennsylvania respectively. Franklin County was more likely to impose sentences that were 1 month to 1 year longer than the mandatory than Pennsylvania. Pennsylvania, on the other hand, was much more likely to impose sentences of less than one week than Franklin County. This further supports our conclusion that Franklin County tends to impose longer sentences than Pennsylvania, though it is not uniformly the case for every sentence length. Pennsylvania had a greater share of sentences longer than 1 year above the mandatory than Franklin County.

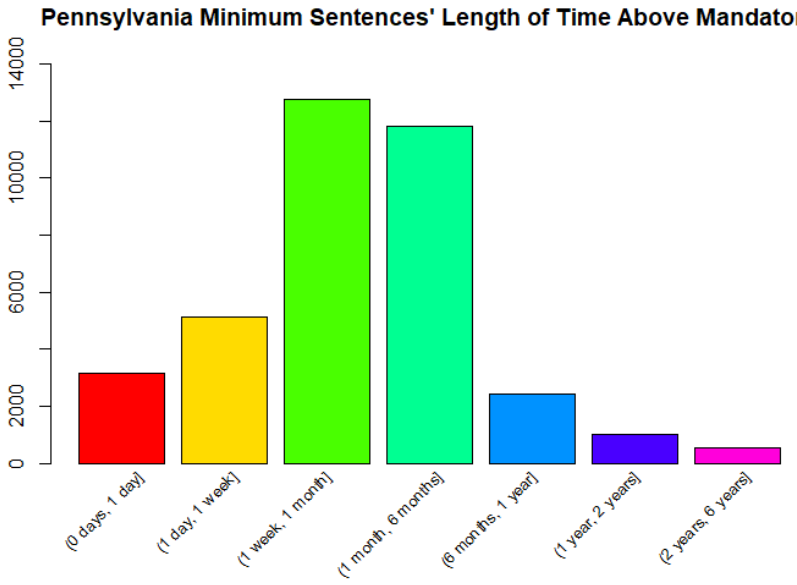


Figure 3.19: *Pennsylvania was most likely to impose sentences that were one week to one month above the mandatory minimum.*

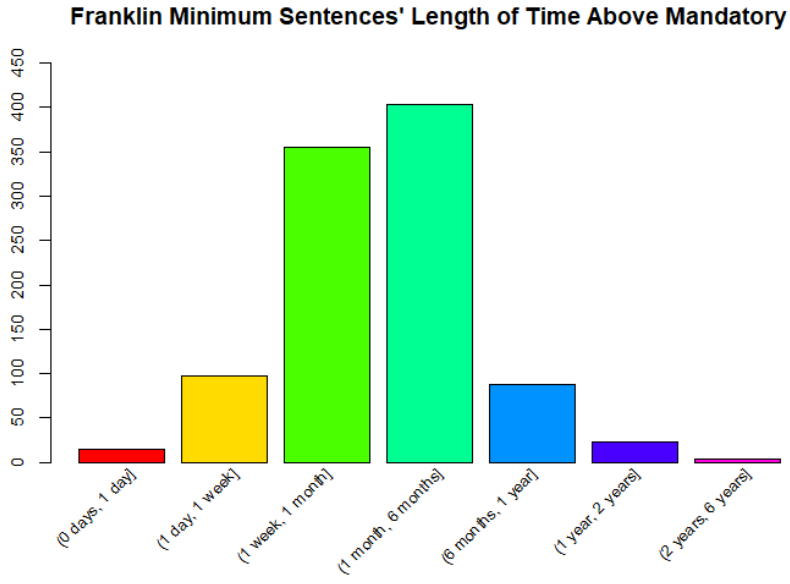


Figure 3.20: *Franklin County was most likely to impose sentences that were 1 to 6 months above the mandatory.*

Maximum incarceration sentences

We looked at the distribution of maximum incarceration sentences to better understand how judges viewed offense severity for DUIs. Figure 3.21 shows that first offenses were much more likely than second and third offenders to result in short sentences of less than 10 months in Franklin County. It was also extremely unlikely for first-time offenders to receive sentences of 30 or more months, whereas over 36% of third- or more-time offenders received sentences of over 50 months. Third-time offenders were also much more likely to receive sentences of 10 to 30 months. While it was still common for first, second, and third-time offenders to not be incarcerated, recidivist offenders received much longer sentences, on average. Interestingly, second-time offenders were more likely to receive no incarceration than first or third-time offenders. About 65% of second-time offenders and 42% of third-time offenders received CIP.

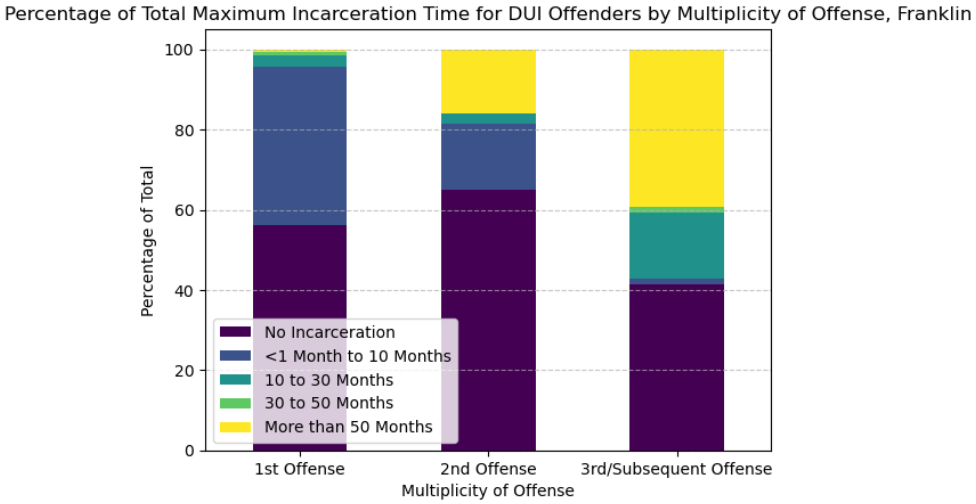


Figure 3.21: *In Franklin County, repeat offenses were much more likely to receive longer sentences; second offenses were more likely than first offenses to receive no incarceration time.*

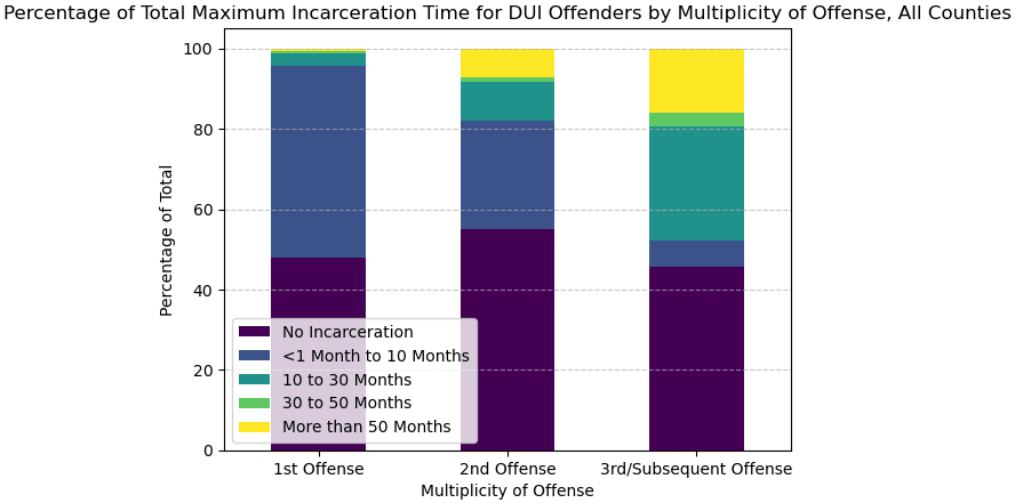


Figure 3.22: *In Pennsylvania, maximum sentences of 10 to 30 months were much more common, but trends found in Franklin County were still present when looking at the entire state.*

3f. What conditions were imposed on DUI offenders?

About 59% of offenses were sentenced at least one restrictive intermediate punishment condition, also known as restrictive probation conditions. These conditions are separate from any imposed treatment and include house arrest, electronic monitoring, intensive supervision, and work release. In Franklin County, by far the most common restrictive probation conditions were electronic monitoring and work release, either alone or in combination. To examine how these conditions varied by repeat DUI offenders in Franklin County, we explored restrictive probation conditions for first-time offenses, second offenses, and third or subsequent offenses in Figure 3.23. Cases where multiple conditions were assigned were put in the umbrella category "Multiple", except for the combination of electronic monitoring with work release, which was common enough to be grouped separately. Second-time offenders were more likely than first-time offenders and third-time offenders to be given any restrictive conditions, with first-time offenders being the least likely. Second and third-time offenders are also far more likely to be given electronic monitoring and work release, or otherwise multiple types of restrictive conditions for the same offense. Third and subsequent offenses are less likely to involve electronic monitoring.

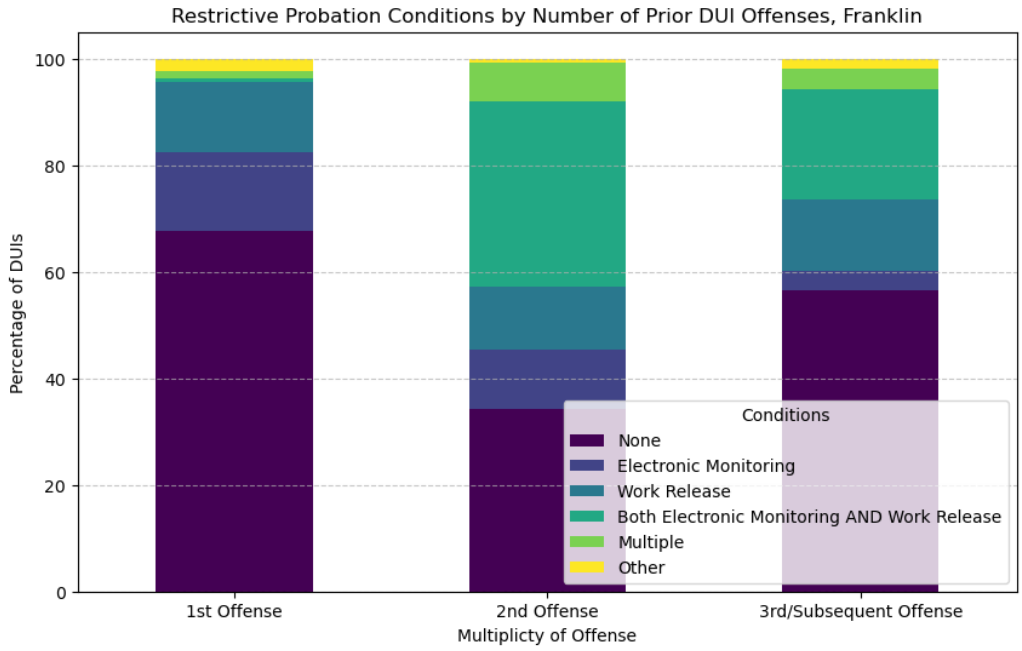


Figure 3.23: *Second-time offenders were more likely than first or third-time offenders to be issued restrictive probation conditions.*

PART IV: COUNTY COMPARISONS

Research Questions

4a. How did Franklin County's DUI rate compare to similar counties?

4b. How did Franklin County's law enforcement presence compare to similar counties?

4c. How did Franklin County's tier distribution, average BAC, and offense multiplicity distribution compare to those of similar counties?

4d. How did Franklin County's DUI crash rates compare to similar counties?

4e. Did similar counties also have a high proportion of young drivers committing DUIs?

Primary Findings

- Franklin County did not stand out in DUI rate, offense breakdown, tier breakdown, or DUI-related crashes compared to similar counties in Pennsylvania.
- Franklin County had a higher rate of DUI involvement from young individuals than all but one other county in Pennsylvania.

Methodology and Data

Choosing similar counties

To determine which counties were most similar to Franklin County in terms of demographics, we used the U.S. Census's summary of Pennsylvania counties as of 2020 (America Counts Staff, 2023). We only considered Pennsylvania counties as we can reasonably rely on continuity in laws and enforcement practices within Pennsylvania, which provides a good baseline of comparison. The Census' summary provided county-level information on population, diversity (determined by percentage of white population and prevalence of race and ethnicity), and the percentage of population that is over 16.

The counties determined to be most similar to Franklin when looking at population size, diversity index, and percentage of population of driving age as of 2020 were Centre County and Beaver County. Additionally, Adams County had the closest population density to Franklin County as of 2020 and is adjacent to Franklin County on the Pennsylvania-Maryland border, making it a logical choice for comparison. Importantly, these counties have considerable variation in these metrics.

County	Total Population	Population Density (per sq mi)	Percentage of Population 16+	Percentage of Population that identified as White	Diversity Index
Franklin	155,932	201.9	80.2%	86.3%	0.270
Beaver	168,215	387.0	83.2%	86.2%	0.261
Centre	158,172	142.7	86.8%	83.0%	0.319
Adams	103,852	200.2	82.4%	88.1%	0.243

Table 4.1: *Beaver, Centre, and Adams County were most similar to Franklin County in terms of racial diversity, population, and density.*

Calculating DUI rates

There are several methods to calculate a DUI rate. First, DUI rate can be defined by dividing the number of DUI traffic stops by the driving population – those aged 16 or over – in a region. This gives an idea of how frequently individuals in a population are being stopped for DUI. DUI arrests can also be used instead of stops to calculate DUI rate.

$$\text{DUI Population Rate} = \frac{\text{Number of DUI stops}}{\text{16+ Population}}$$

$$\text{DUI Arrest Rate} = \frac{\text{Number of DUI arrests}}{\text{16+ Population}}$$

Recall from Part II that DUI arrest rates more accurately reflect enforcement than offending. These estimates, therefore, should be interpreted conservatively.

To account for enforcement levels, another way to calculate DUI rate is to divide the total number of DUI traffic stops out of the total number of traffic stops in a region. This method captures the frequency of DUI arrests that stem from traffic stops. Because of these limitations, we calculated all three rates and used them to draw conclusions.

$$\text{DUI Stop Rate} = \frac{\text{Number of DUI stops}}{\text{Number of stops}}$$

We utilized the U.S. Census Bureau to obtain total and driving population estimates for Pennsylvania counties and the CAD data we requested from the PSP to obtain the number of DUI stops in each county for 2020-2022. We also used the Pennsylvania Universal Crime Reporting System's Arrest Distribution Reports to obtain DUI arrests per year by county from 2020 to 2022. We calculated all three definitions of DUI rate for each county in Pennsylvania for those years.

Calculating enforcement rates

As discussed above, DUI incident rates likely more accurately reflect enforcement than they do behaviors. Still, calculating enforcement rates – defined as the number of traffic stops out of the driving population – yields more insight into the level of activity in a certain region. We calculated enforcement intensity by dividing the total number of traffic stops by the 16 and over population. We did this twice with CAD stop

counts and CDR record counts for each PSP Troop. Because the CDR information in our PSP requested dataset was limited, we used the CDR reports released by the Pennsylvania State Police from 2021 and 2022 to obtain information on the number of CDR records.

$$\text{CAD Enforcement Rate} = \frac{\text{Number of CAD stops}}{\text{16+ Population}}$$

$$\text{CDR Enforcement Rate} = \frac{\text{Number of CDR records}}{\text{16+ Population}}$$

The interpretability of these rates is limited by the multiple influences on the number of traffic stops. For example, a very active police force may catch more individuals offending and increase the rate, while a community in which more people offend may also increase the rate. The FBI strongly advises against using crime statistic data to make ranked comparisons. In their document on the proper use of Uniform Crime Reporting Statistics (Federal Bureau of Investigation, 2017), they state:

> Data users should not rank locales because there are many factors that cause the nature and type of crime to vary from place to place. UCR statistics include only jurisdictional population figures along with reported crime, clearance, or arrest data. Rankings ignore the uniqueness of each locale. (p. 1)

We extracted information on alcohol seized during discretionary searches by each PSP Troop station from the 2022 CDR Report (Engel et al., 2023). Once this data was extracted, each Troop station was assigned to a county in Pennsylvania based on in which county the Troop station is located (Pennsylvania State Police, n.d.). An approximation of the number of discretionary searches that produced alcohol by each Troop station was determined by multiplying total number of discretionary searches with the percentage that resulted in alcohol confiscation.

Calculating recidivism rates, intoxication intensity rates, and crash rates

Due to the limitations of estimating offending and enforcement rates, we also make comparisons from examining recidivism, intoxication intensity, and crash rates. To determine trends in DUI offense and tier rates, the 2020 and 2021 Pennsylvania sentencing datasets were used. The data was cleaned to only include data from offenses with “DUI” in the offense label. Using the methodology described in the Methodology section of Part III, we calculated the proportions of each tier and multiplicity of the offense for each examined county. Using the BACs from our requested PSP CAD records, we determined the average BAC of each county from January 1, 2020, through September 30, 2023. We removed any BACs that were above 0.40 for this calculation.

To determine trends in crash rates between Franklin County and similar counties, we used the PennDOT crash data for the years 2018-2022 and divided by the respective driving populations from each year. Crash rates are also affected by enforcement via deterrence and incapacitation. These rates should be considered with those limitations in mind.

Results

4a. How did Franklin County's DUI rate compare to similar counties?

Figure 4.1 plots the DUI Arrest Rate for our four selected counties from 2020 to 2022 using the driving population of those aged 16 and over, respectively. Franklin County's DUI rate was not notable for any included years and followed a trend similar to Beaver and Centre Counties. Adams County, however, had a steep jump from 2020 to 2021 which it maintained into 2022.

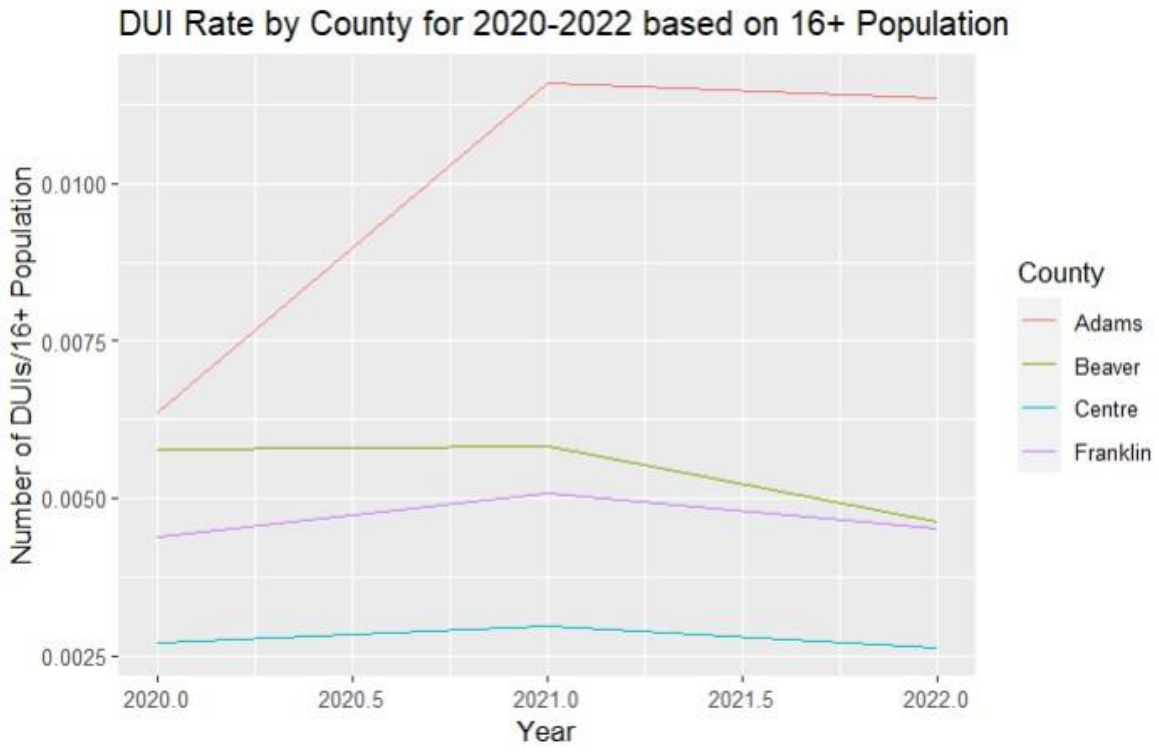


Figure 4.1: *Franklin County's DUI Arrest Rate was not notable for any of the studied years.*

To examine this across time and the state of Pennsylvania, we found the DUI Population Rate from the CAD records supplied by the PSP. These rates represent the total number of DUI stops that occurred from January 2020 through September 2023 divided by the estimated 2022 16 and over population of each county. Population estimates were obtained from the 2022 ACS 5-year estimate tables. There was considerable variation in DUI Population Rates among the similar counties. The DUI Population Rates are mapped in Figure 4.2. Franklin County's DUI Population Rate was 0.59%, which is almost exactly equal to the state's average of 0.60%. Centre County's DUI Population Rate, 0.32%, was in the lowest bracket, and Adams County had the highest DUI Population Rate in the state at 1.64%.

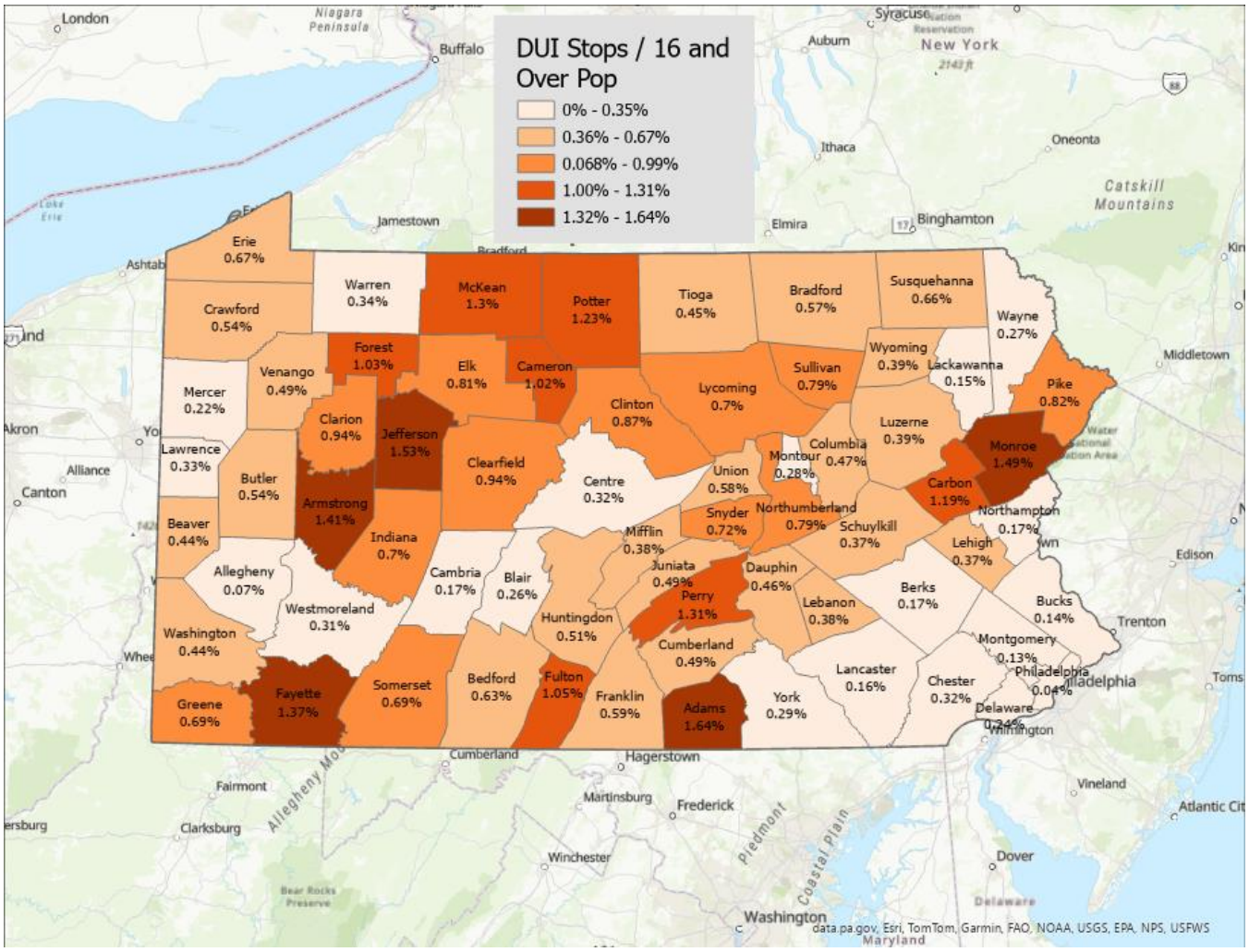


Figure 4.2: *Franklin County's DUI Population Rate was very near the state's average.*

Because DUI Population Rate is heavily dependent on the level of enforcement, we also examined the DUI Stop Rate for each county. This is the proportion of traffic stops that resulted in a DUI. This normalizes DUI occurrences by enforcement so that we can estimate DUI rates accounting for the frequency of traffic stops in a county. We map the DUI Stop Rates in Figure 4.3. As we reported in Part II, the percentage of stops resulting in DUI in Franklin County was 1.7%. This was low compared to other counties in Pennsylvania, and the lowest out of Beaver, Centre, and Adams Counties. Franklin County and Centre County had similar low DUI Stop Rates while Beaver County and Adams County had high DUI Stop Rates.

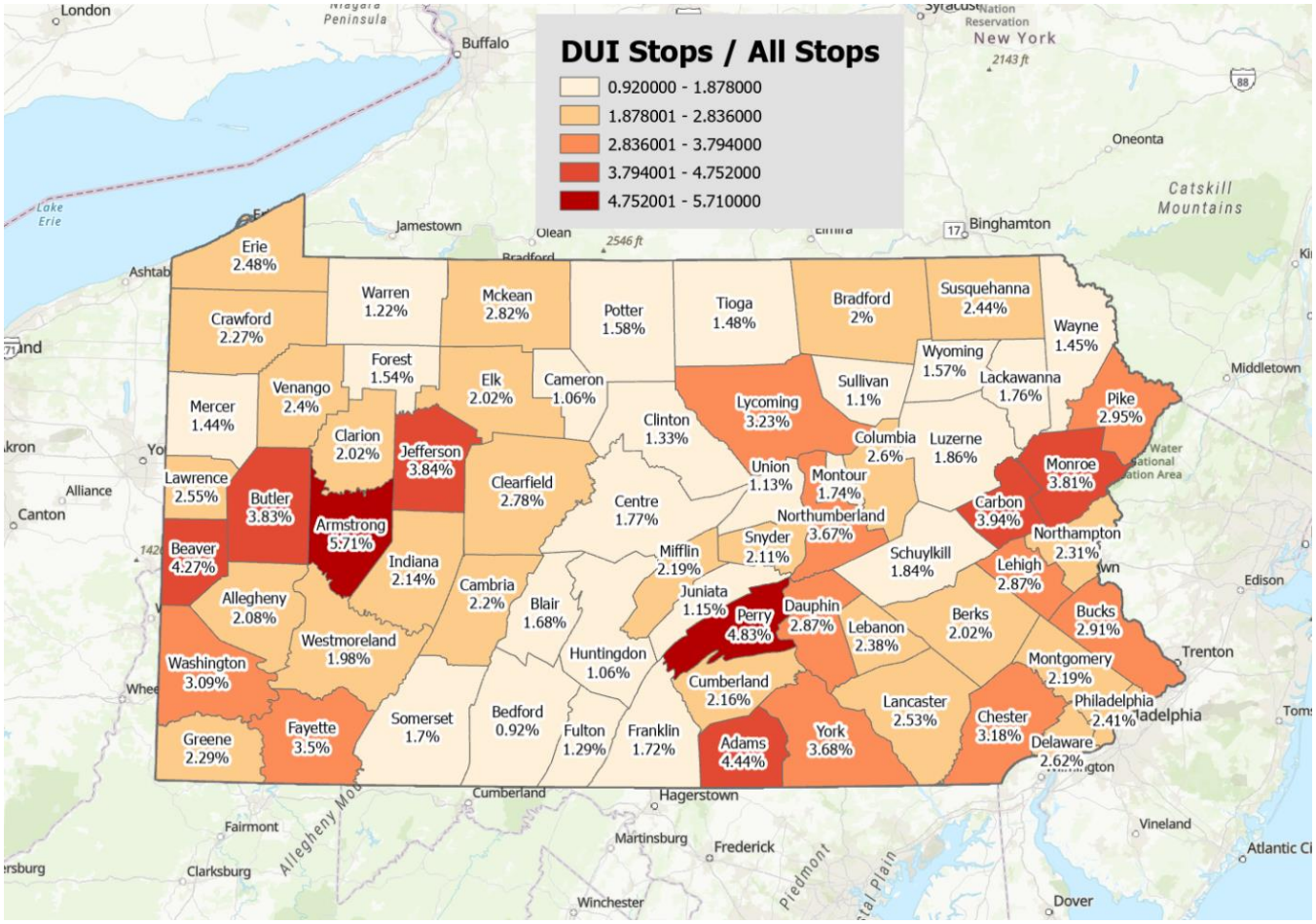


Figure 4.3: *Franklin County was in the lowest DUI Stop Rate bracket, but this distribution was right-skewed.*

4b. How did Franklin County's law enforcement presence compare to similar counties?

Figure 4.4 maps the CAD Enforcement Rate – the total number of CAD stops (not necessarily DUI) out of the driving-aged population – for each Pennsylvania county. This rate attempts to measure the activity level of the police force in traffic safety. Franklin County's Enforcement Rate was 43%. Beaver's and Centre's Enforcement Rates were much lower at 13% and 23% respectively. Adams' is higher than Franklin's, but not dramatically. Three-quarters of counties had Enforcement Rates below 51%, so we believe Franklin County does not have a high Enforcement Rate relative to the state or similar counties. It is worth noting that the counties with smaller populations, such as Potter, Cameron, and Fulton, tend to have larger Enforcement Rates. This suggests that the number of stops – essentially, traffic enforcement – may be more uniform across the state and not as strongly dependent upon the counties' populations.

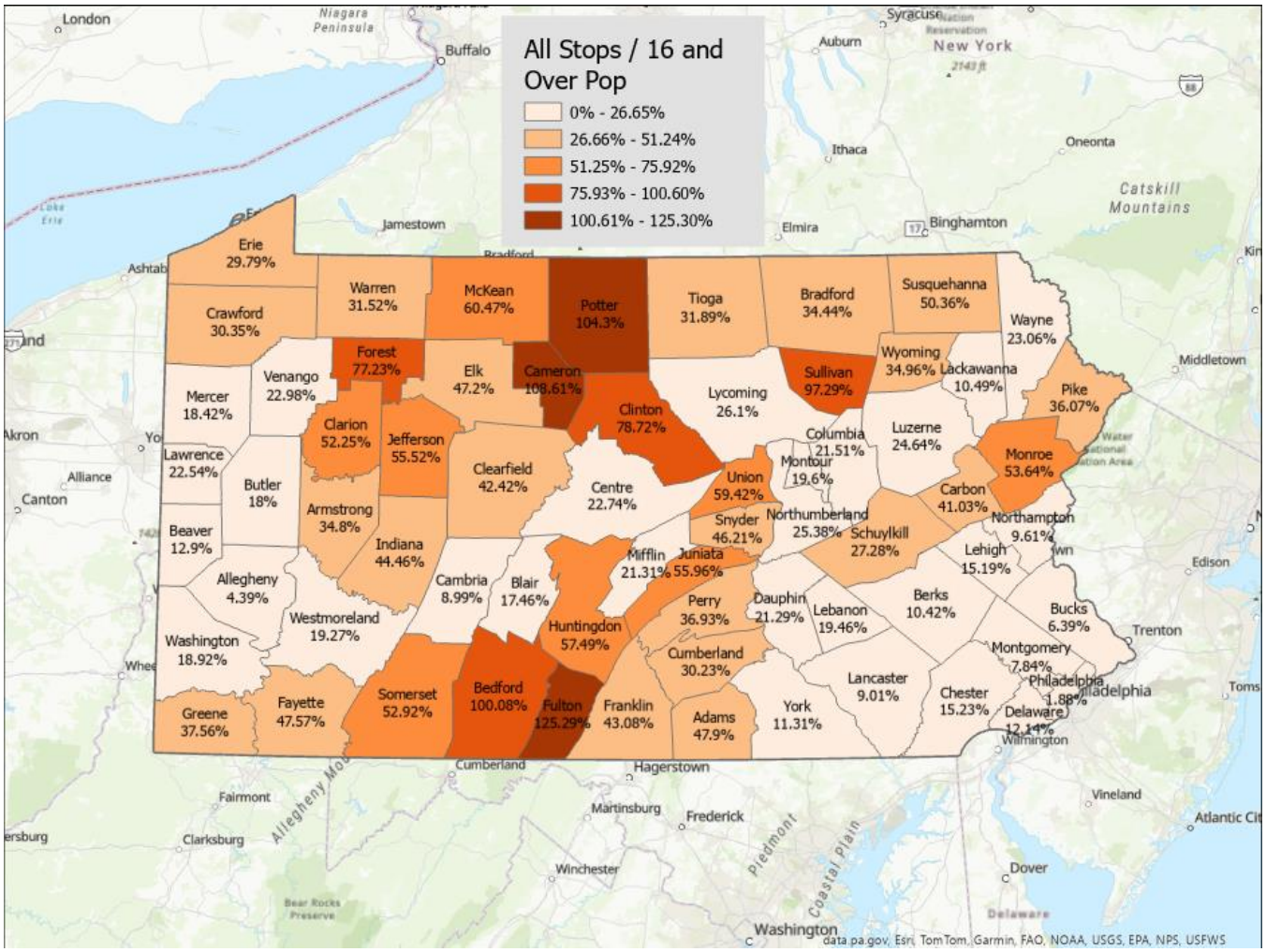


Figure 4.4: *Enforcement Rates varied substantially across Pennsylvania; Franklin County's rate was not notable.*

4c. How did Franklin County's tier distribution, average BAC, and repeat offense rates compare to those of similar counties?

The limitations of using DUI incident rates implore the use of other metrics to measure problem severity. Investigating the intensity and seriousness of the observed offenses can yield more insight into the relative intensity of intoxication and the frequency of recidivism, which may better help quantify the problem.

Tier distribution

Using the sentencing data, Figure 4.5 shows the proportions of different Tier levels in Franklin County and similar counties. Following its trend, Adams County has an incredibly high Tier 3 rate; around 80% of sentenced DUIs in Adams County were Tier 3. Of the three, Franklin County was on the higher side for percentage of Tier 3 offenses; however, the distribution remains close to that of Beaver and Centre.

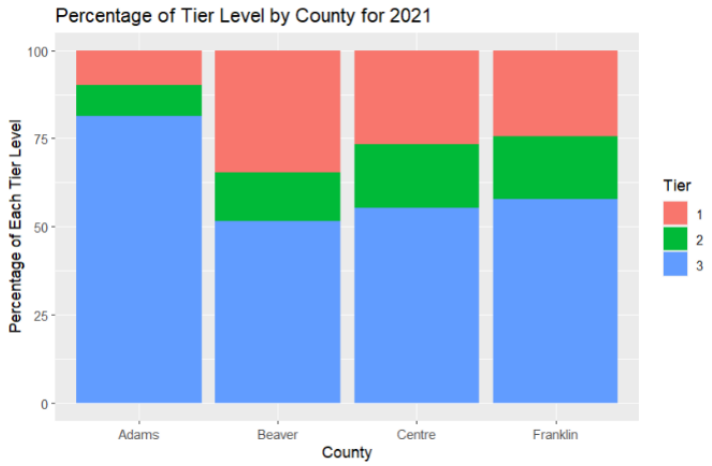


Figure 4.5: *Franklin County had similar proportions of Tier 1, 2, and 3 offenses as Centre County.*

Average BAC

The map in Figure 4.6 examines drunk-driving severity through the average BAC of drivers taken from the PSP CAD traffic stops. Franklin County's average BAC of 0.063 was again below the state's county average of 0.075. Of the similar counties, Centre had the highest average of 0.085 and Beaver had the lowest at 0.049.

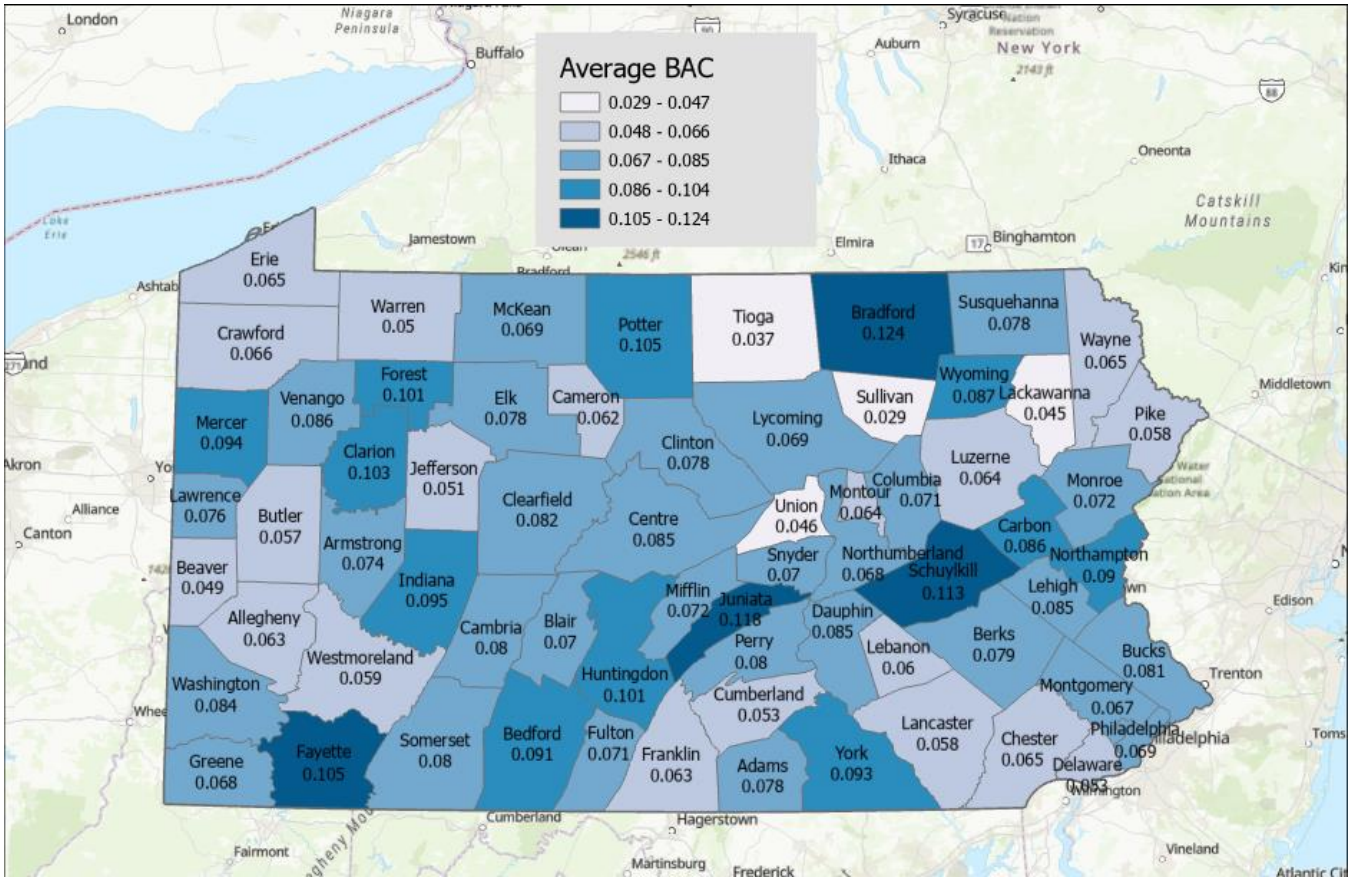


Figure 4.6: *Average BAC ranged from 0.037 to 0.124, and Franklin County remained on the low end of the spectrum.*

Repeat offenses

In Figure 3.4 from Part III, we showed that about 43% of Franklin County's DUI charges were repeat offenses. Here, using the 2017-2021 sentencing datasets, we examined repeat offense rates for the state to put Franklin County's results into context.

The lollipop chart in Figure 4.7 plots each county's percentage of DUI offenses that were classified as repeat offenses, excluding offenses for which the multiplicity was not recorded.[8] The lollipops are centered on 43.5% of those DUI offenses being repeat offenses, which was the average repeat offense rate of all Pennsylvania counties. Franklin County (orange) was near that average, at around 41.5%, and had the lowest proportion of repeat offenses out of the three selected similar counties (blue). Centre County had the sixth highest repeat offense rate of all counties at 54.7%. Adams County and Beaver County had rates that were closer to the average, at 45.9% and 43.4% respectively.

These rates do not necessarily mean that Franklin County had less DUI recidivism than similar counties. Rather, counties with lower proportions of repeat offenses may have more new individuals committing DUIs. To investigate this, we plotted the counts of first-time DUI offenses (solid) and repeat offenses (dashed) sentenced between 2017 through 2021 in Figure 4.8. Figure 4.8 reveals that DUI offenses in Franklin County were more likely to be first-time offenses throughout the 5-year period. Franklin County had the largest consistent difference between first-time offenses and repeat offenses among all four counties, but both first and repeat offenses followed a similar trend. This was not seen in Beaver County, where in 2020 first-time offenses increased and repeat offenses decreased. This suggests:

- Franklin County has a higher proportion of first-time DUI offenses than similar counties. Adams, Beaver, and Centre Counties had much closer counts of first and repeat offenses.
- Problem drinkers (likely repeat offenders) and non-problem drinkers in Franklin County may have been affected by the pandemic in similar magnitudes. This was not seen in Adams, Beaver, and Centre Counties.

As in Figure 3.1, Figure 4.8 also suggests that Centre and Franklin Counties had a general decline in DUI cases sentenced over the 5-year period, but this trend is not seen in the similar counties. Beaver and Adams Counties appeared to be generally increasing in DUI sentencing over the 5-year period. Properly investigating recidivism rates and trends requires tracking individuals through the criminal justice system. Furthermore, it is important to remember that these rates only capture those individuals who get caught, which is likely much lower than the actual offending rate.

[8] DUI offenses without a multiplicity generally regarded offenses that did not concern the actual act of DUI. For example, fleeing an officer while DUI, aggravated assault while DUI, and homicide by vehicle while DUI were considered DUI offenses but did not have associated multiplicities.

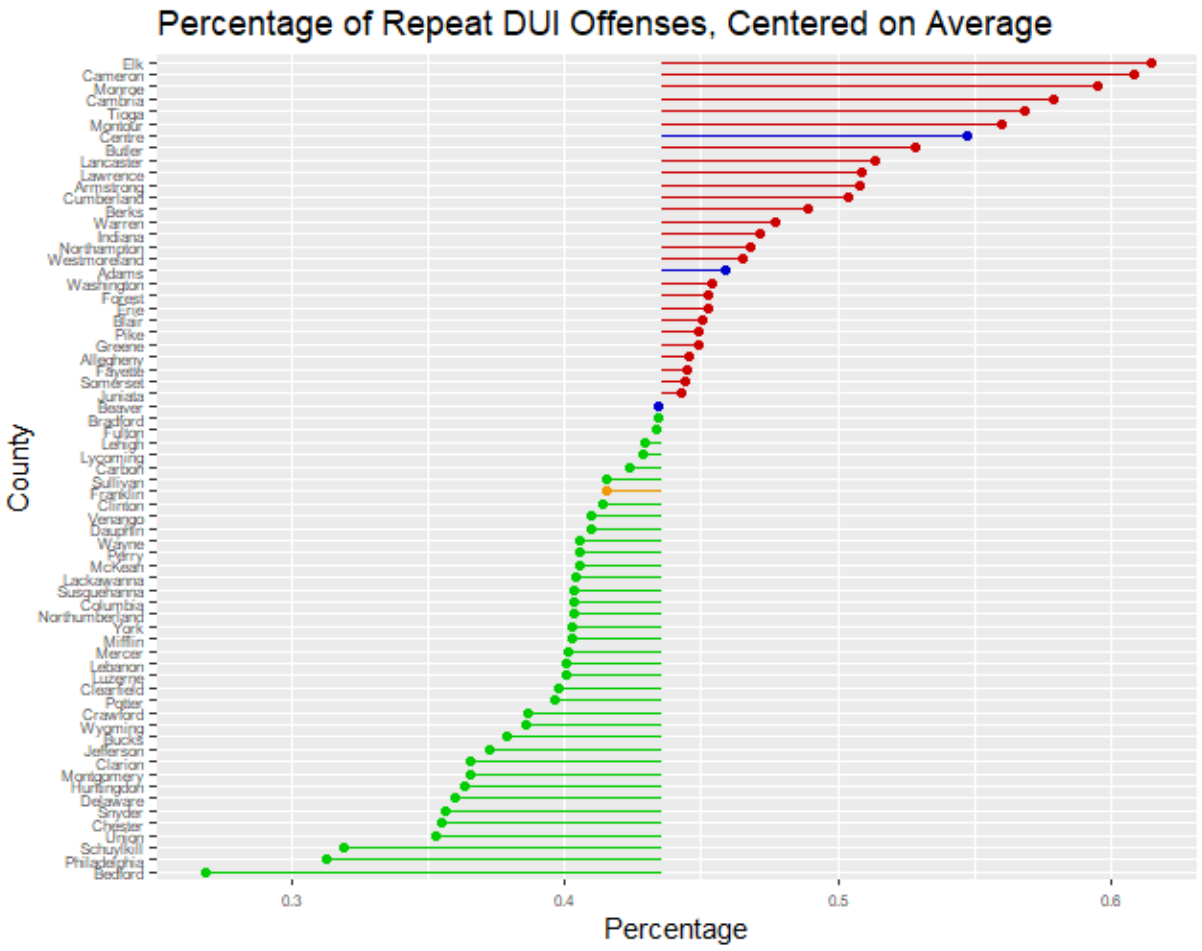


Figure 4.7: *Franklin County (orange) is near the county average for the proportion of DUI offenses that were repeat offenses.*

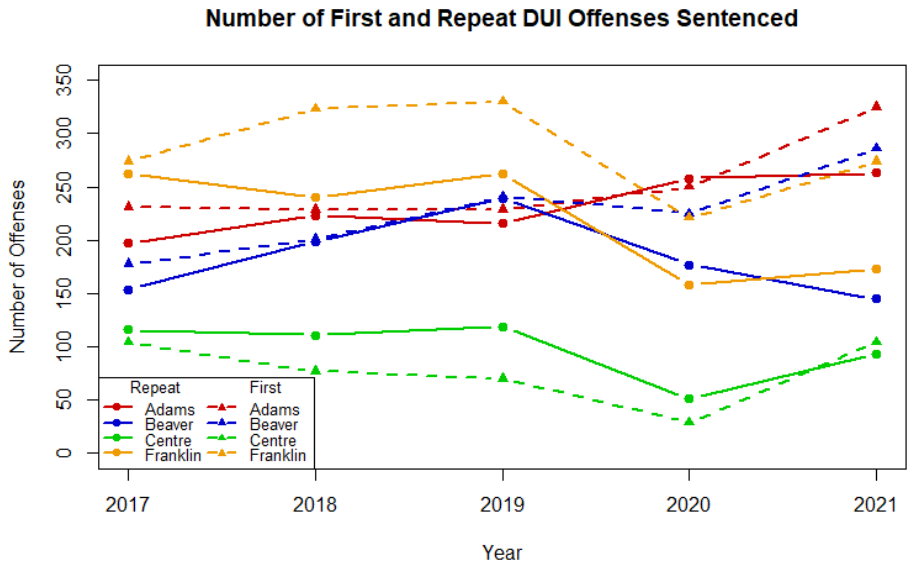


Figure 4.8: *Franklin County had higher counts of first offenses (dashed) than repeat offenses (solid) for all examined years.*

4e. How did Franklin County's DUI crash rates compare to similar counties?

The graphs in Figures 4.9, 4.10, and 4.11 regard DUI crashes in Franklin County and its similar counties. Figure 4.9 shows the number of crashes per year, and Figure 4.10 shows this as a proportion of the driving population. Franklin County was on the higher side for the number of DUI crashes over the examined period but tended to be lower than Beaver County. When examining DUI crashes as a proportion of the driving population in Figure 4.10, Adams, Beaver, and Franklin Counties clustered together around 0.13% while Centre County had a distinctly lower crash rate.

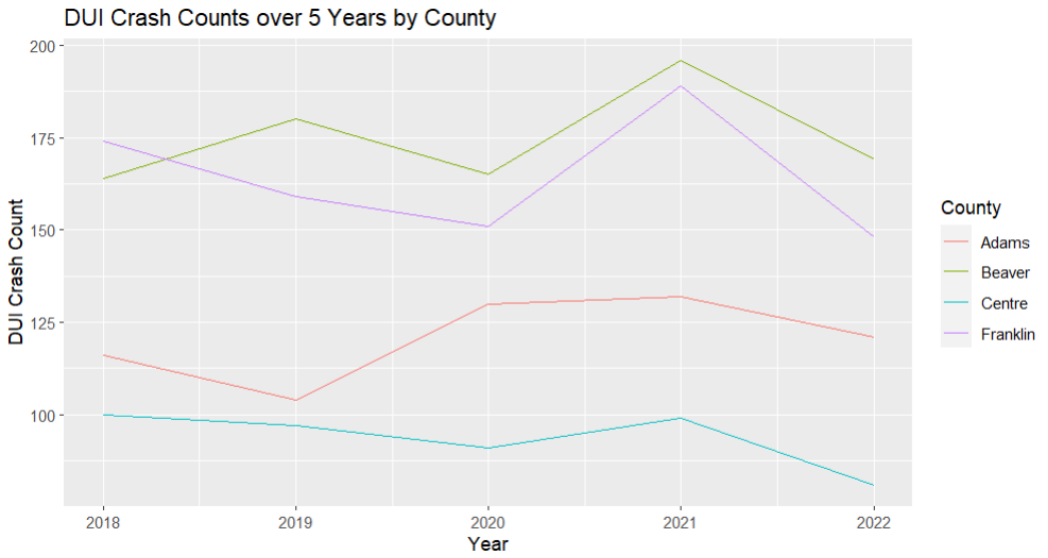


Figure 4.9: *DUI crashes increased in all similar counties in 2021, but most dramatically in Franklin and Beaver Counties.*

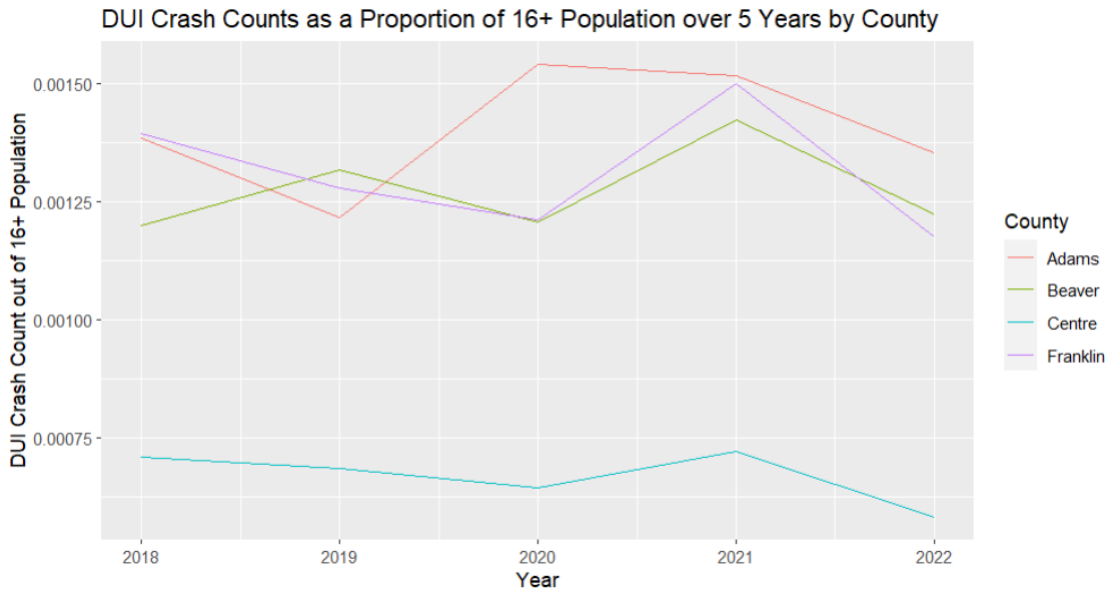


Figure 4.10: *Centre County had the lowest DUI crash rate out of the driving population; the other three counties had similar crash rates.*

To clarify whether these DUI crash rates are a product of lower crash rates in general, we plotted the proportion of DUI crashes out of total crashes in Figure 4.11. Beaver County's higher proportion indicates that a larger share of crashes regarded DUIs. This may mean that DUIs are more dangerous in Beaver County. Considering that Beaver County also had a high DUI Stop Rate in Figure 4.3 and a lower enforcement rate in Figure 4.4, it is possible that Beaver County's lower enforcement rate is contributing to its higher crash rates.

Centre County, again, is lowest in this regard, possibly indicating that DUI is more controlled in this county. Franklin County is again not notable in its proportions of crashes relative to its driving population or total crashes. Together, these graphs indicate that Franklin County did not experience a significantly higher rate of DUI crashes compared to similar counties given its population size.

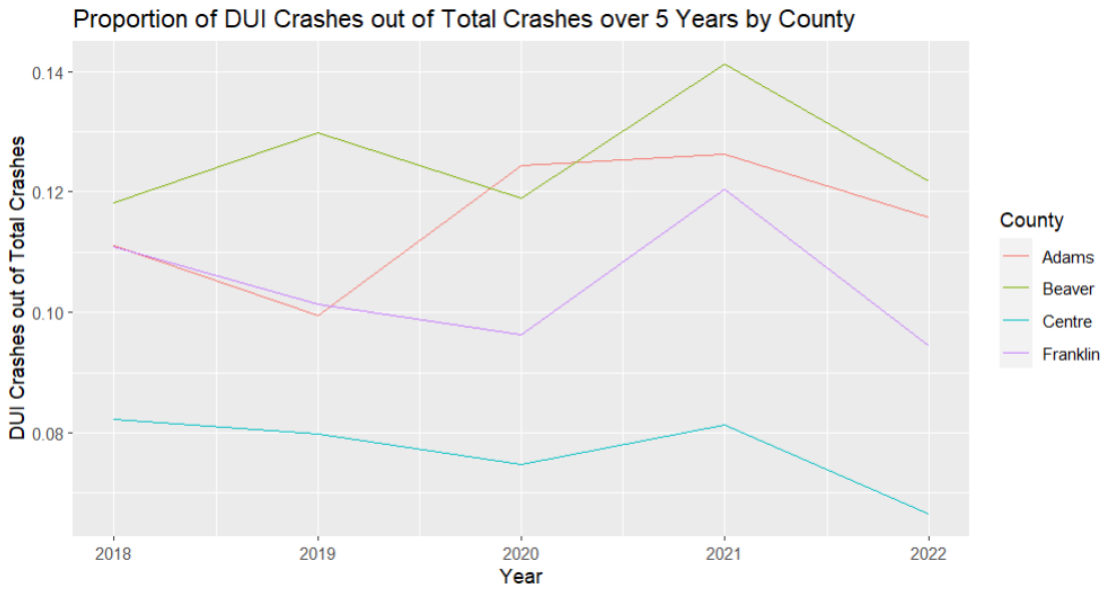


Figure 4.11: *Plotting the proportion of DUI crashes to all crashes reveals that Franklin County is in between Beaver County and Centre County.*

4e. Did similar counties also have a high proportion of young drivers committing DUIs?

In Part III, Figure 3.10, we saw that Franklin County had a disproportionate share of DUI offenders aged 18-24 when compared with its population and with the 18-24 DUI rate of the state. Here, we investigated whether any other counties experienced this disproportionate rate of young DUI offenders relative to their population. We calculated the following relative risk ratio for each county, using the sentencing datasets and the 2021 ACS 5-year estimates, and mapped the results in Figure 4.12.

$$\text{Relative Risk} = \frac{\text{Proportion of DUI offenders aged 18-24}}{\text{Proportion of county population aged 18-24}}$$

DUI offenders in Franklin County were 2.71 times more likely to be aged 18-24 than general population citizens. Franklin County had the second highest relative risk ratio of all Pennsylvania counties. For context, the next highest counties were Juniata (2.54) and Somerset (2.41). This further reinforces that young individuals in Franklin County are particularly susceptible to DUI, and that prevention efforts should target those individuals. Interestingly, despite Centre County hosting Penn State University, it had the lowest ratio – DUI offenders were 37% less likely to be aged 18-24 than the population.

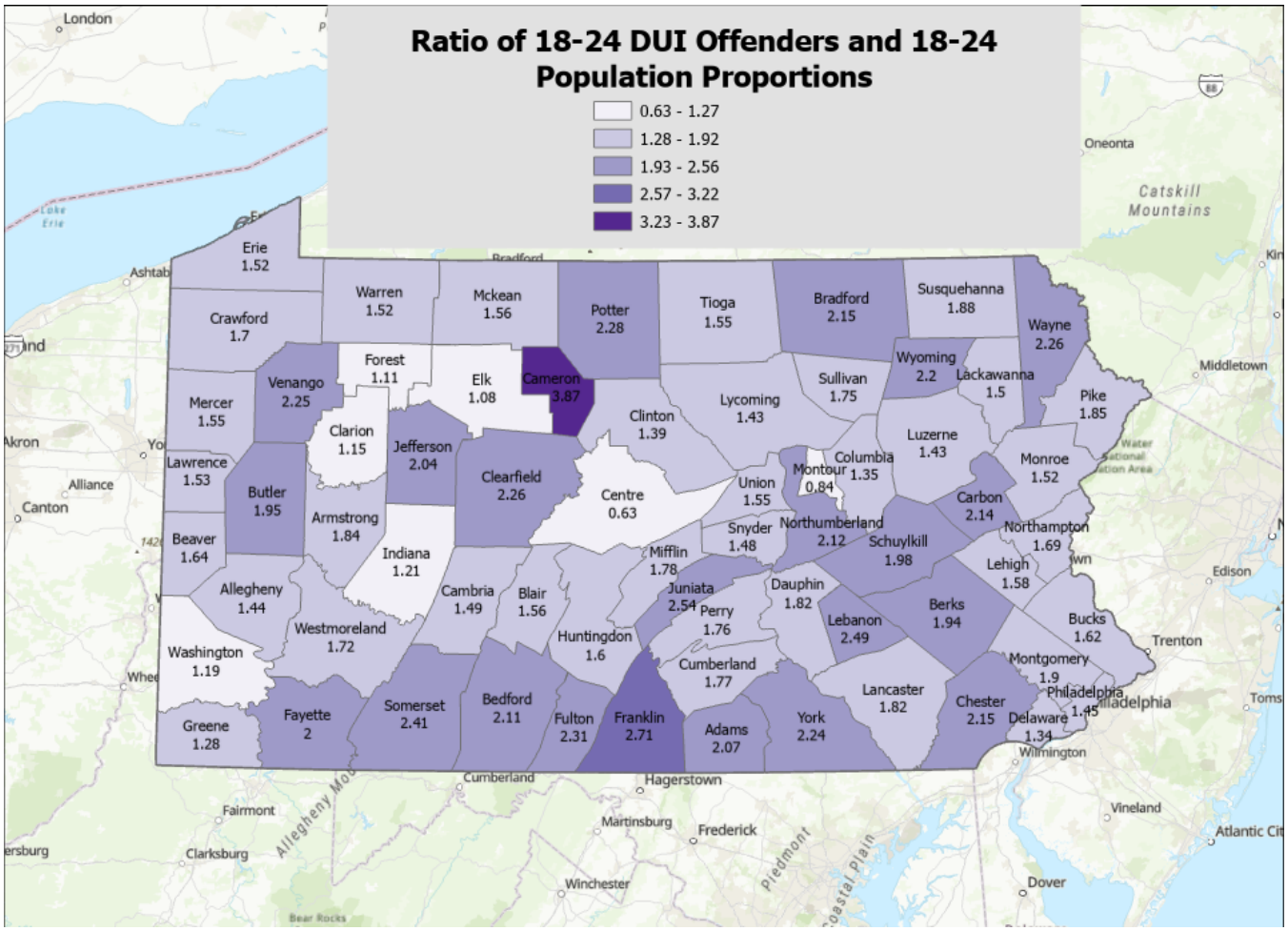


Figure 4.12: *Franklin County was second highest in the state for having a disproportionate share of individuals aged 18-24 involved in DUI offenses.*

DISCUSSION AND RECOMMENDATIONS

Recommendation #1: Prioritize prevention and deterrence of alcohol and controlled substance DUIs to marijuana DUIs

Crash data in Franklin County suggests that alcohol and controlled substances besides marijuana are most responsible for crashes. On average over the ten-year study period, alcohol was involved in 79% of crashes and controlled substances other than marijuana were involved in 18% of crashes. Only considering the seven years in which marijuana crashes occurred, marijuana was involved in less than 5% of crashes (see Figures 1.11 and 1.12). While the frequency of marijuana DUI crashes has increased since the drug's medical legalization, there were on average 7 marijuana-related crashes per year compared to the average of 1,281 alcohol-related crashes per year.

As discussed in Question 1g, research suggests that the misuse of other drugs, and particularly the combination of multiple drugs, is much more dangerous in the context of DUIs (Romano & Voas, 2011) than marijuana use. Several papers found no evidence (Neavyn et al., 2014; Romano et al., 2013) or marginal evidence (Neavyn et al., 2014; Romano & Voas, 2011; Romano, Voas, & Camp, 2017) that marijuana by itself induces crashes or fatalities. It was found to contribute less to crashes and fatalities than other drugs and alcohol (Marillier & Verstraete, 2019; Romano et al., 2013; Romano & Voas, 2011). Combining substances has been found to increase the odds of injury or death (Neavyn et al., 2014; Romano & Voas, 2011). While marijuana has been shown to exert some effects on driving ability, impairment, and crashes in the studies cited here, the misuse of other drugs (prescribed and illicit) has been shown to be more concerning in a DUI context. This suggests that resources may be best spent preventing DUIs involving alcohol, which made up over 82% of Franklin's DUI-related crashes in 2022, and other controlled substances, given the importance of preventing dangerous crashes and recidivism. Therefore, we recommend that Franklin County prioritize curbing other drug-related and alcohol-related DUI behavior.

We do not suggest that Franklin County ignore marijuana DUI behavior. Marijuana use has been associated with increased intent to DUI in college students (Hultgren et al., 2021). In Question 1f, we found that younger drivers were more likely to be involved in marijuana DUI crashes relative to other age groups (see Figure 1.20). Consequently, we also recommend that Franklin County focus prevention efforts regarding marijuana use and driving on young people.

Recommendation #2: Focus prevention and deterrence strategies on young males

Traditionally, young people are most susceptible to DUI. Our research suggests that this is especially true for Franklin County, where young people are sentenced for DUIs at a rate higher than that of the rest of Pennsylvania (see Figure 3.10) and commit DUIs that are, on average, of higher severity than other age groups (see Figure 3.11). We also found that younger drivers were overrepresented in DUI crashes (see

Figure 1.15). Additionally, we found that Franklin County had the second-highest ratio of DUI offenders aged 18-24 to the proportion of the population aged 18-24 (see Figure 4.12). Prevention efforts should also focus on men, who make up under half of Franklin's population yet commit over 78% of its DUIs (see Figure 3.5). Men were also nearly twice as likely as women to be involved in a DUI crash (see Figure 1.18).

Given the large number of DUIs that are committed by certain demographics, prevention and treatment efforts in Franklin County could be targeted with that knowledge in mind. Some research indicates that males aged 21 through 29 drinking between 10PM and 4AM on weekends are groups that can be effectively targeted for reducing DUIs (Miller, Levy, & Lestina, 1998). The data from Franklin County supports this, as most DUI traffic stops occurred between 8PM and 4AM. Deterrence strategies could not only target certain demographics of potential offenders, but also focus on certain times and DUI hot spot locations.

Recommendation #3: Expand treatment sentencing options to combat DUI recidivism

In both Franklin County and Pennsylvania as a whole, DUI recidivism is very common. In the five years of sentencing data used for this research, around 43% of DUIs in Franklin County were repeat offenses. Significant resources should be allocated to preventing DUI offenders from reoffending. Particular efforts should be put towards the populations that commit DUIs at the highest rate and are most likely to engage in this behavior.

In our analysis for Question 3d, we found that first-time DUI offenses led to incarceration in about 40% of cases, but this increased to 60% for third or subsequent offenses (see Figure 3.15). While it may seem intuitive to increase punishment severity via incarceration for subsequent offenses, this practice has not been found to be successful in reducing DUI.

Prior research has found that those who engage in DUI tend to fall into two broad categories: problem drinkers and non-problem drinkers (Rider et al., 2006; Stringer, 2021). Problem drinkers tend to be more certain that they will be punished for DUI yet are more likely to engage than non-problem drinkers (Stringer, 2021). This suggests that severe punishment, like incarceration, would not deter these individuals from DUI. Similarly, other research found that jail may deter first-time offenders but not recidivists from DUI (Bouffard, Niebuhr, & Exum, 2017; Rahman & Weatherburn, 2021; Stringer, 2021).

Problem-drinkers, however, are not a homogenous group (Nochajski & Stasiewicz, 2006). One study found that problem-drinkers are more likely to suffer from comorbid disorders that may impact the success of drug and alcohol treatment programs (Schaffer et al., 2007). Nearly half of repeat DUI offenders qualified for a mental illness that was not substance-related (Schaffer et al., 2007). Another study found that DUI recidivism was higher for individuals with ADHD as well as individuals with lengthier and more serious criminal histories, suggesting that DUI might be one outlet for a greater pattern of behavior (Nelson et al., 2016). As such, traditional sanctions like education and incarceration may be insufficient for dealing with these individuals (Nelson et al., 2016; Schaffer et al., 2007).

As in every Pennsylvanian county, individuals convicted of a first or second-offense DUI are mandated to attend a DUI alcohol education program that often focuses on lectures and films encouraging better

drinking habits and educating about the consequences of drinking and driving (see Table 3.3; Osilla et al., 2017). These programs are educational in nature and offenders often do not receive treatment for alcohol use disorders (AUDs). On their own, these education programs have been found to be ineffective (Miller et al., 2015). Although there is not strong existing research on this topic, multithreaded programs involving licensing sanctions, AUD treatment, and DUI education have shown promise in decreasing DUI recidivism (Miller et al., 2015; Osilla et al., 2017).

Preliminary research has found success at reducing recidivism with cognitive behavioral treatment (CBT), a type of rehabilitation (Moore et al., 2008; Osilla et al., 2017). CBT focuses on coping skills and problem solving. In the context of alcohol and DUI, CBT involves addressing cognitive mechanisms that lead to one drinking and driving, such as the inability to handle high-risk situations appropriately, instead of addressing alcohol consumption directly. A study involving first-time DUI offenders aged 18-35 showed that participants in the CBT program reported significantly greater alcohol reduction after a year compared to a group who received standard alcohol and drug education and a group who received no treatment (Osilla et al., 2017). Repeat offenders are more likely to suffer from significant physiological distress and severe AUDs that need treatment (Osilla et al., 2017). Efforts to curb recidivism may be most effective offering therapy and treatment to prevent alcohol misuse and bolster coping strategies.

Considering this research, we advise that Franklin County courts, to the extent of their ability, work towards customizing sentences to the specific needs of the individual an opposed to sentencing strictly for punishment. Incarceration should be limited when sentencing recidivist DUI offenders. We encourage the courts to consider increasing the frequency of mandated treatment or CIP when sentencing recidivist DUI offenders. We also recommend that Franklin County work towards further developing programs that incorporate therapy and treatment alongside punishment and education on DUIs and their impacts.

Recommendation #4: Develop non-carceral deterrence methods

Research on the effects of prison on DUI recidivism is limited (Rahman & Weatherburn, 2021). However, Rahman & Weatherburn (2021) found that there is little evidence that prison reduces DUI recidivism beyond the initial reduction effect caused by the incapacitation of the offender. Incapacitation is one method of prevention that involves directly restricting one's ability to offend, and prison is one example of this. They concluded that effectiveness of prisons in curbing DUIs is largely limited to the fact that people who are in prison are directly prevented from driving. Even when strictly referring to incapacitation, the resources spent on imprisoning DUI offenders may be more well-spent in other incapacitating measures. Specifically, they acknowledged evidence that ignition interlocks, which are discussed further below, can provide the same incapacitation as prisons but for a significantly cheaper cost.

Research also points towards significant costs and limited effectiveness of preventing DUIs via policing. Stringer (2018) found that increased DUI arrests are correlated with decreased fatalities from alcohol related crashes. However, their research also found that the relationship is not linear and there are diminishing returns for increased arrests, suggesting that policymakers should explore alternative methods of reducing DUI crashes to policing. This is consistent with other research that some drinkers are receptive to punitive deterrents and problem drinkers are likely to drink and drive regardless and be repeat offenders (Stringer, 2021). On the other hand, Fell et al. (2014) found that a 10% increase in the DUI arrest

rate is associated with a 1% reduction in the drinking driver crash rate, and that the number of sworn officers per capita in an area was negatively correlated to the number of impaired-driver crashes.

Another deterrent policing strategy, DUI checkpoints, involves police cars stationing on the side of the road and stopping drivers randomly or systematically for signs of drug use. Erke et al. (2009) found that the presence of visible DUI checkpoints reduces alcohol-related crashes by 17%. While research on the effects of policing as a means to prevent DUIs is mixed, DUI checkpoints allow districts to leverage information on when and where DUIs are most likely to occur to efficiently prevent crashes.

Given the limited effectiveness of carceral sentencing on DUI prevention, many other strategies have emerged, to varying success. A preliminary evaluation of the effectiveness of some of these methods is below.

Ignition interlocks are a physical mechanism that prevent drivers from starting their vehicles until they produce a blood alcohol content below a set limit. While research suggests that these devices are effective in preventing DUIs while the lock is installed, research is split on whether or not the lock prevents DUI recidivism in any meaningful way once the lock is uninstalled (Miller et al., 2015). In essence, ignition interlocks provide the same incapacitation effect as imprisonment by preventing offenders from recidivating for a certain amount of time, but at a significantly cheaper cost (Rahman & Weatherburn, 2021). They also do not provide the same adverse health effects on offenders and families as prisons do. More research could be used to determine the effects on recidivism after the lock has been installed for some time and then uninstalled.

Another prevention strategy, victim impact panels (VIPs), involve those who have been affected negatively by DUIs speaking directly to offenders. However, several studies have found these to be ineffective in reducing recidivism, with no significant differences in recidivism between groups who received standard treatment plus VIPs and those who received just standard treatment (Miller et al., 2015).

Civil fines are another way that governments attempt to curb DUI. One study on 26 states found that establishing mandatory minimum fines for first-time offenders was correlated with a decrease in crash fatalities in only six states, showing little evidence that fines serve as a significant deterrent (Wagenaar, 2007). They concluded that mandatory penalty policies for first-time DUI offenders had only a modest effect on deterring or preventing DUI. Other research indicates that experience with DUI sanctions does not significantly influence DUI behavior and intentions (Bouffard, Niebuhr, & Exum, 2017).

Stringer (2018) found that alcohol consumption is a very strong predictor of fatal DUI crashes. This may suggest that an effective way to prevent alcohol-related crashes is to broadly limit alcohol consumption and treat alcohol use disorders. While this may seem like a daunting task, many of the people who have alcohol use disorders are problem drinkers and recidivist offenders. Offering therapy to treat recidivist offenders may play in limiting alcohol consumption, which Stringer's research suggests may lead to fewer DUI-related fatalities. This strategy also addresses a population which, as discussed above, is often not receptive to means of deterrence like fines and jail time (Bouffard, Niebuhr, & Exum, 2017; Rahman & Weatherburn, 2021; Stringer, 2021).

Recommendation #5: Continue DUI research

The current study is a robust overview of DUI in Franklin County that sought to identify the vulnerable populations towards which to target reform efforts, the prevalence of specific substances, the dangerous or criminal consequences of DUI, and factors that may contribute to recidivism. Now that these baselines have been established in Franklin County, more focused research into some of these issues can further inform prevention and deterrence approaches. We provide four examples here.

Invest in research focused on the individuals engaging in DUI

We pinpointed the demographic most susceptible to DUI to be young males, but other works suggest that those who engage in DUI may be members of groups who engage in DUI for different reasons and thus may require different prevention and deterrence methods. Due to data limitations, we were unable to identify these specific populations for Franklin County individuals. For example, we could not identify problem drinkers, those with comorbid mental health conditions, or those with prior criminal justice experience. While we could determine which defendants in DUI cases were recidivists, we could not further investigate the reasons behind their recidivism.

Continuing research into precisely determining the factors associated with DUI recidivism in Franklin County may help its agencies strengthen its prevention, treatment, and deterrence efforts. One potential avenue is a longitudinal research study which would track participants over the course of several years to investigate recidivism predictors and trends. This research would be experimental as opposed to observational, which would allow for causality to be inferred.

Evaluate the effectiveness of Franklin County's current DUI education curriculum or treatment programs

More research, both broadly on the effectiveness of DUI treatment and prevention programs and Franklin County's specific DUI programs would be an insightful and helpful supplement to the current research. Specifically, detailed information on the individuals who went through various state-sponsored programs or county programs for offenders would allow us to identify how likely those people were to recidivate compared to those in other states or countries who attended different programs, or those who attended no program at all. This can help Franklin County improve its current resources.

Investigate alternate transportation options in Chambersburg and Waynesboro

In Question 1b, we found that DUI crashes were more prevalent closer to areas dense with liquor outlets in Chambersburg and Waynesboro. This suggests that individuals who drink socially may be more susceptible to DUI. Indeed, some research has found that the most common reasons for driving while intoxicated are that the driver had no other way home (25%) and that alcohol consumption occurred during a meal (17%) (Alonso et al., 2015). Consequently, Franklin County should consider investigating alternate transportation programs in these two towns.

In a meta-analysis of 125 studies evaluating the effectiveness of alternate transportation methods in reducing DUI, Fell et al. (2020) determined that there was limited evidence that these methods are universally lucrative. Nevertheless, they documented that successful alternate transportation programs have the following characteristics:

- Socially acceptable and viewed as safe to the community
- High public awareness of their existence
- Cheap or free
- Available year-round

- Provide rides to and from drinking establishments
- Have sustainable funding

We recommend that Franklin County research the potential of alternate transportation programs in Chambersburg and Waynesboro with preliminary investigations into the behaviors, desires, and opinions of their residents. This can help Franklin County agencies devise an alternate transportation strategy that maximizes success and efficiency.

Study Limitations

Crashes

First, due to the structure of the PennDOT crash datasets, we could not determine which driver was impaired. The DRINKING_DRIVER, DRUGGED_DRIVER and MARIJUANA_DRUGGED_DRIVER columns applied to crashes as a whole and indicated whether at least one driver involved was intoxicated with the relevant substance. Therefore, we could only determine which crashes involved DU I rather than individuals. This means that we could not exactly determine which age groups were more likely to drive intoxicated.

Second, the only three variables that identified specific substances DRINKING_DRIVER, DRUGGED_DRIVER and MARIJUANA_DRUGGED_DRIVER. There was no way to determine which substances, if not alcohol and marijuana, were used. Additional research into the substances used may prove useful in directing prevention or rehabilitative efforts.

Traffic stops

As discussed extensively in the Datasets section of the Background, analyses using the traffic stop data were limited by the quality of the data received from the PSP. The lack of identifiers in the CAD and CDR datasets meant that records could not be matched, and demographics could not be analyzed in greater detail and confidence.

Sentencing

Future research on this topic could include more years to better analyze time series trends in DUIs. Given that there were only five years of DUI sentencing used for the dataset, it was challenging to establish trends in how DUIs in Franklin changed over time. Furthermore, it was not feasible using this data to examine the effects of COVID-19 on DUIs because DUIs were often sentenced a year or multiple years after the offense. So, many DUIs that occurred in 2021 would be in future datasets and were not included in this research. More years would also increase the number of DUIs being examined, because with the five years used for this research, there were only 2,426 DUI cases in Franklin County.

County comparisons

We did not know the residence of drivers involved in DUI crashes or traffic stops. This limits our hypotheses on the effectiveness of directing location-specific prevention measures. For example, if all DUIs that occur in Franklin County involve drivers who do not live there, then focusing prevention efforts on Franklin County drivers may be insufficient to combat DUI. More specific individual data could reveal patterns about the travel habits of these drivers and help refine prevention efforts. Furthermore, not knowing more about the individuals involved in DUI meant we could not investigate how socioeconomic status may be influential in DUI. It also prevented us from studying it as a comparison demographic for determining which counties were similar to Franklin County.

We were limited by our inability to extrapolate significant knowledge about law enforcement in Pennsylvania counties. Reliable information about the number of officers assigned to each county was scarce, which made quantifying law enforcement's presence a challenge. Using PSP Troops as a proxy indicator of law enforcement rates is also somewhat unreliable; even though the Troops have various stations that are located within specific counties, officers may not limit their patrol to the counties in which the station is located.

BIBLIOGRAPHY

Datasets

Pennsylvania Department of Transportation. (December 6, 2023a). *Pennsylvania local roads* [Shapefile]. Retrieved January 2, 2024, from https://data-pennshare.opendata.arcgis.com/datasets/PennShare::pennsylvania-local-roads-2/about

Pennsylvania Department of Transportation. (December 6, 2023b). *RMSSEG (state roads)* [Shapefile]. Retrieved January 2, 2024, from https://data-pennshare.opendata.arcgis.com/datasets/PennShare::rmsseg-state-roads/about

Pennsylvania Department of Transportation. (December 6, 2023c). *RMSTRAFFIC (traffic volumes)* [Shapefile]. Retrieved January 2, 2024, from https://data-pennshare.opendata.arcgis.com/datasets/PennShare::rmstraffic-traffic-volumes/about

Pennsylvania Liquor Control Board. (n.d.). *LicenseListWithSecondaries.csv* [Dataset]. Retrieved December 12, 2023, from https://plcbplus.pa.gov/pub/Default.aspx?PossePresentation=LicenseSearch

Pennsylvania Uniform Crime Reporting System. (n.d.). https://www.ucr.pa.gov/PAUCRSPUBLIC/SRSReport/CrimeDistribution

U.S. Census Bureau. (2022). Race. *American Community Survey, ACS 1-Year Estimates Detailed Tables, Table B02001*. Retrieved February 1, 2024, from https://data.census.gov/table/ACSDT1Y2022.B02001?t=Race and Ethnicity&g=050XX00US42055

U.S. Census Bureau. (2020). PROFILE OF GENERAL POPULATION AND HOUSING CHARACTERISTICS. *Decennial Census, DEC Demographic Profile, Table DP1*. Retrieved March 12, 2024, from https://data.census.gov/table?t=Age%20and%20Sex&g=010XX00US&d=DEC%20Demographic%20Profile

U.S. Census Bureau. "Age and Sex." *American Community Survey, ACS 5-Year Estimates Subject Tables, Table S0101*, 2022, https://data.census.gov/table/ACSST5Y2022.S0101?t=Age and Sex&g=050XX00US42001,42007,42027,42055. Accessed on March 12, 2024.

Software and Packages

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1), 1-48. https://doi.org/10.18637/jss.v067.i01

Esri Inc. (2023). *ArcGIS Pro* (Version 3.2). https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview

Harris, C. R., Millman, K. J., van der Walt, S. J., Gommers, R., Virtanen, P., Cournapeau, D., … Oliphant, T. E. (2020). Array programming with NumPy. *Nature*, *585*, 357–362. https://doi.org/10.1038/s41586-020-2649-2

Hunter, J. D. (2007). Matplotlib: A 2D graphics environment. *Computing in Science & Engineering*, *9*(3), 90–95.

Matplotlib Development Team. (2023). *Matplotlib* (Version 3.5.2). https://matplotlib.org/

McKinney, W. (2023). *pandas* (Version 1.5.3). https://pandas.pydata.org/

Microsoft Corporation. (2018). *Microsoft Excel*. Retrieved from https://office.microsoft.com/excel

Moon, K. (2020). *webr: Data and Functions for Web-Based Analysis*. R package version 0.1.5, https://CRAN.R-project.org/package=webr

Python Software Foundation. (2023). *Python* (Version 3.11.4). https://www.python.org/

R Core Team. (2023). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Signorell, A. (2023). *DescTools: Tools for Descriptive Statistics*. R package version 0.99.52, https://CRAN.R-project.org/package=DescTools

Waskom, M. L., (2021). seaborn: statistical data visualization. Journal of Open Source Software, 6(60), 3021, https://doi.org/10.21105/joss.03021.

Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York.

Wickham, H., & Bryan, J. (2023). *readxl: Read Excel Files*. R package version 1.4.3, https://CRAN.R-project.org/package=readxl

Wickham, H, François, R., Henry, L., Müller, K., & Vaughan, D. (2023). *dplyr: A Grammar of Data Manipulation*. R package version 1.1.4, https://CRAN.R-project.org/package=dplyr

Wickham, H., Vaughan, D., & Girlich, M. (2023). *tidyr: Tidy Messy Data*. R package version 1.3.0, https://CRAN.R-project.org/package=tidyr

Wuertz, D., Setz, T., Chalabi, Y., & Boshnakov, G. N. (2023). *timeDate: Rmetrics - Chronological and Calendar Objects*. R package version 4032.109, https://CRAN.R-project.org/package=timeDate

Works Cited

Administrative Office of Pennsylvania Courts. (n.d.). *Clean slate, expungement and limited access*. The Unified Judicial System of Pennsylvania. Retrieved February 16, 2024, from https://staging.pacourts.us/learn/learn-about-the-judicial-system/clean-slate-expungement-and-limited-access

Ahmed, A., Farkas, A., & Beck, K. (2011). *A social network analysis of alcohol-impaired drivers in Maryland: An egocentric approach*. State Highway Administration. https://roads.maryland.gov/OPR_Research/MD-11-SP808B4E_Social-Network-Analysis-of-Impaired-Drivers-Report.pdf

Alam, M. S., & Tabassum, N. J. (2023). Spatial pattern identification and crash severity analysis of road traffic crash hot spots in Ohio. *Heliyon*, *9*(5). https://doi.org/10.1016/j.heliyon.2023.e16303

Alonso, F., Pastor, J. C., Montoro, L., & Esteban, C. (2015). Driving under the influence of alcohol: Frequency, reasons, perceived risk and punishment. *Substance Abuse Treatment, Prevention, and Policy*, *10*. https://doi.org/10.1186/s13011-015-0007-4

America Counts Staff. (2023, July 13). *Pennsylvania population hit 13 million in 2020*. Census.gov. https://www.census.gov/library/stories/state-by-state/pennsylvania-population-change-between-census-decade.html

Barbosa, C., Dowd, W., Barnosky, A., & Karriker-Jaffe, K. (2021). *Assessing pandemic-driven changes in alcohol consumption*. RTI International. https://www.niaaa.nih.gov/sites/default/files/FINAL_REPORT--NIAAAPandemicDrivenAlcCons.pdf

Bouffard, J. A. Niebuhr, N., & Exum, M. L. (2017). Examining specific deterrence effects on DWI among serious offenders. *Crime & Delinquency*, *63*(4), 1923-1945. https://doi.org/10.1177/0011128716675359

Chen, H., Chen, Q., Chen, L., & Zhang, G. (2016). Analysis of risk factors affecting driver injury and crash injury with drivers under the influence of alcohol (DUI) and non-DUI. *Traffic Injury Prevention*, *17*(8), 796-802. https://doi.org/10.1080/15389588.2016.1168924

Daimler, E., & Cotton, C. (2019). *DUI recidivism by drug preference: The case of Georgia*. University of Georgia College of Public Health. Retrieved February 20, 2024, from https://publichealth.uga.edu/wp-content/uploads/2019/11/Daimler-SOPH2019-DUI-recidivism-poster-TSREG.pdf

Delaney, H. D., Kunitz, S. J., Zhao, H., Woodall, W. G., Westerberg, V., Rogers, E., & Wheeler, D. R. (2004). Variations in jail sentences and the probability of re-arrest for driving while intoxicated. *Traffic Injury Prevention*, *6*(2), 105-109. https://doi.org/10.1080/15389580590931554

Delano, J. (September 5, 2023). *Pa. state senator: Medical marijuana card is no proof of DUI, laws should change*. CBS News. Retrieved January 25, 2024, from https://www.cbsnews.com/pittsburgh/news/pa-state-senator-medical-marijuana-card-is-no-proof-of-dui-laws-should-change/

Drew, L., Royal, D., Moulton, B., Peterson, A., & Haddix, D. (2010). *Volume I: Summary report: National survey of drinking and driving attitudes and behaviors: 2008* (DOT HS 811 342). https://www.nhtsa.gov/sites/nhtsa.gov/files/811343.pdf

Engel, R., Calnon Cherkauskas, J., Corsaro, N., & Yildirim, M. (2023). *Pennsylvania State Police traffic stop study: 2022 annual report January 1 – December 31, 2022*. National Policing Institute. Retrieved January 28, 2024, from https://www.psp.pa.gov/data/Documents/CDR/CDR_2022.pdf

ESRI (n.d.). *How Emerging Hot Spot Analysis works*. ArcGIS Pro. Retrieved January 15, 2024, from https://pro.arcgis.com/en/pro-app/latest/tool-reference/space-time-pattern-mining/learnmoreemerging.htm

Federal Bureau of Investigation. (n.d.). *Crime Data Explorer*. Retrieved March 12, 2024, from https://cde.ucr.cjis.gov/LATEST/webapp/#/pages/explorer/crime/arrest

Federal Bureau of Investigation. (2017). *Uniform Crime Reporting statistics: Their proper use*. https://ucr.fbi.gov/ucr-statistics-their-proper-use

Fell, J. C., Scolese, J., Achoki, T., Burks, C., Goldberg, A., & DeJong, W. (2020). The effectiveness of alternate transportation programs in reducing impaired driving: A literature review and synthesis. *Journal of Safety Research*, 75, 128-139. https://doi.org/10.1016/j.jsr.2020.09.001

Fell, J. C., Waehrer, G., Voas, R. B., Auld-Owens, A., Carr, K., & Pell, K. (2014). Effects of enforcement intensity on alcohol impaired driving crashes. *Accident Analysis & Prevention*, *73*, 181-186. https://doi.org/10.1016/j.aap.2014.09.002

Gong, Y., Lu, P., & Yang, X. T. (2023). Impact of COVID-19 on traffic safety from the "lockdown" to the "new normal": A case study of Utah. *Accident Analysis & Prevention*, *184*. https://doi.org/10.1016/j.aap.2023.106995

Hultgren, B. A., Waldron, K. A., Mallett, K. A., & Turrisi, R. (2021). Alcohol, marijuana, and nicotine use as predictors of impaired driving and riding with an impaired driver among college students who engage in polysubstance use. *Accident Analysis & Prevention*, *160*. https://doi.org/10.1016/j.aap.2021.106341

Husch Blackwell. (2021). *Pennsylvania: State-by-state COVID-19 guidance*. https://www.huschblackwell.com/pennsylvania-state-by-state-covid-19-guidance

Impinen, A., Rahkonen, O., Karjalainen, K., Lintonen, T., Lillsunde, P., & Ostamo, A. (2009). Substance use as a predictor of driving under the influence (DUI) rearrests. A 15-year retrospective study. *Traffic Injury Prevention*, *10*(3), 220-226. https://doi.org/10.1080/15389580902822725

Knoth, L. (2015). Conviction or diversion? An analysis of first-time DUI offenders in Pennsylvania. *Pennsylvania State University*. https://etda.libraries.psu.edu/files/final_submissions/10422

Kramer, J. H., & Ulmer, J. T. (1996). Sentencing disparity and departures from guidelines. *Justice Quarterly*, *13*(1), 81-106. https://doi.org/10.1080/07418829600092831

Lapham, S. C., Skipper, B. J., Hunt, W. C., & Chang, I. (2006). Do risk factors for re-arrest differ for female and male drunk-driving offenders? *Alcoholism: Clinical and Experimental Research*, *24*(11), 1603-1741. https://doi.org/10.1111/j.1530-0277.2000.tb01966.x

Law Enforcement Information Technology Standards Council. (2009). *Standard functional specifications for law enforcement computer aided dispatch (CAD) systems*. Retrieved January 28, 2024, from https://bja.ojp.gov/sites/g/files/xyckuh186/files/media/document/leitsc_law_enforcement_cad_systems.pdf

Levine, N. (2017). The location of late night bars and alcohol-related crashes in Houston, Texas. *Accident Analysis and Prevention*, *107*, 152-163. http://dx.doi.org/10.1016/j.aap.2017.05.010

Lidbe, A., Adanu, E. K., Tesla, E., & Jones, S. (2020). Role of passengers in single-vehicle drunk-driving crashes: An injury-severity analysis. *Safety*, *6*(2), 30. https://doi.org/10.3390/safety6020030

Li, Z., Wang, W., Liu, P., Bigham, J., & Ragland, D. R. (2013). Using geographically weighted Poisson regression for county-level crash modeling in California. *Safety Science*, *58*, 89-97. http://dx.doi.org/10.1016/j.ssci.2013.04.005

Liu, J., Li, X., & Khattak, A. J. (2020). An integrated spatio-temporal approach to examine the consequences of driving under the influence (DUI) in crashes. *Accident Analysis and Prevention*, *146*. https://doi.org/10.1016/j.aap.2020.105742

Liu, P., & Fan, W. (2019). Modeling head-on crash severity with drivers under the influence of alcohol or drugs (DUI) and non-DUI. *Traffic Injury Prevention*, *21*(1), 7-12. https://doi.org/10.1080/15389588.2019.1696964

Manning, A. R., Romano, E., Diebold, J., Nochajski, T. H., Taylor, E., Voas, R. B., & Scherer, M. (2021). Convicted drinking and driving offenders: Comparing alcohol use before and after the pandemic outbreak. *Alcoholism Clinical & Experimental Research*, *45*, 1225-1236. https://doi.org/10.1111/acer.14613

Marillier M., & Verstraete, A. (2019). Driving under the influence of drugs. *Wiley Interdisciplinary Reviews: Forensic Science*, *1*(3). https://doi.org/10.1002/wfs2.1326

Martin, T. L., Solbeck, P. A. M., Mayers, D. J., Langille, R. M., Buczek, Y., & Pelletier, M. R. (2013). A review of alcohol-impaired driving: The role of blood alcohol concentration and complexity of the driving task. *Journal of Forensic Sciences*, *58*(5), 1238-1250. https://doi.org/10.1111/1556-4029.12227

Maxwell, J. C., & Freeman, J. E. (2007). Gender differences in DUI treatment in Texas. *Traffic Injury Prevention*, *8*(4), 353-360. https://doi.org/10.1080/15389580701586810

Miller, T., Levy, D. T., & Lestina, D. C. (1998). How drunk are U.S. drivers? Measuring the extent, risks, and costs of drunk driving. *Annu Proc Assoc Adv Automot Med*, *42*, 353-367. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3400188/

Miller, P. G., Curtis, A., Sønderlund, A., Day, A., & Droste, N. (2015). Effectiveness of interventions for convicted DUI offenders in reducing recidivism: A systematic review of the peer-reviewed scientific literature. *The American Journal of Drug and Alcohol Abuse*, *41*(1), 16-29. https://doi.org/10.3109/00952990.2014.966199

Moore, K. A., Harrison, M., Young, M. S., & Ochshorn, E. (2008). A cognitive behavioral therapy treatment program for repeat DUI offenders. *Journal of Criminal Justice*, *36*, 539-545. https://doi.org/10.1016/j.jcrimjus.2008.09.004

Neavyn, M. J., Blohm, E., Babu, K. M., & Bird, S. B. (2014). Medical marijuana and driving: A review. *Journal of Medical Toxicology*, *10*, 269-279. https://doi.org/10.1007/s13181-014-0393-4

Nelson, S. E., Belkin, K., LaPlante, D. A., Bosworth, L., & Schaffer, H. J. (2016). A prospective study of psychiatric comorbidity and recidivism among repeat DUI offenders. *Archives of Scientific Psychology*, *3*(1), 8-17. https://doi.org/10.1037%2Farc0000009

Nemphos Braue. (June 30, 2023). *Cannabis legalization timeline in Maryland*. Retrieved March 26, 2024, from https://nemphosbraue.com/news/cannabis/a-timeline-of-cannabis-in-maryland/#:~:text=In%202014%2C%20medical%20cannabis%20was,get%20here%2C%20and%20what's%20next%3F

Nochajski, T. H., & Stasiewicz, P. R. (2006). Relapse to driving under the influence (DUI): A review. *Clinical Psychology Review*, *26*, 179-195. https://doi.org/10.1016/j.cpr.2005.11.006

NORML. (n.d.). *Pennsylvania drugged driving*. Retrieved January 25, 2024, from https://norml.org/laws/drugged-driving/pennsylvania-drugged-driving/

Osilla, K. C., Kulesza, M., & Miranda, J. (2017). Bringing alcohol treatment to driving under the influence programs: Perceptions from first-time offenders. *Alcoholism Treatment Quarterly*, *35*(2), 113–129. https://doi.org/10.1080/07347324.2017.1288484

Pennsylvania Commission on Sentencing. (2019). *SGS Web Data Codebook: 2001 – 2018 (Public)*. Retrieved March 22, 2023, from https://pcs.la.psu.edu/research-data/request-data-and-reports/

Pennsylvania Department of Health. (n.d.). *Resources for dispensaries*. Retrieved December 12, 2023, from https://www.health.pa.gov/topics/programs/Medical%20Marijuana/Pages/Dispensaries.aspx

Pennsylvania State Police. (n.d.). *Troop directory*. https://www.psp.pa.gov/troop%20directory/Pages/default.aspx

Pew Research Center. (2013, April 4). *Majority now supports legalizing marijuana*. Retrieved March 22, 2024. https://www.pewresearch.org/politics/2013/04/04/majority-now-supports-legalizing-marijuana/

Rahman, S., & Weatherburn, D. (2021). Does prison deter drunk-drivers? *Journal of Quantitative Criminology*, *37*, 979-1001. https://doi.org/10.1007/s10940-020-09476-4

Rider, R., Kelley-Baker, T., Voas, R. B., Murphy, B., McKnight, A. J., & Levings, C. (2006). The impact of a novel educational curriculum for first-time DUI offenders on intermediate outcomes relevant to DUI recidivism. *Accident Analysis & Prevention*, *38*, 482-489. https://doi.org/10.1016/j.aap.2005.11.004

Romano, E., Torres-Saavedra, P., Voas, R. B., & Lacey, J. H. (2013). Drugs and alcohol: Their relative crash risk. *Journal of Studies on Alcohol and Drugs*, *75*(1), 56-64. https://doi.org/10.15288%2Fjsad.2014.75.56

Romano, E., & Voas, R. B. (2011). Drug and alcohol involvement in four types of fatal crashes*. *Journal of Studies on Alcohol and Drugs*, *72*(4), 567-576. https://doi.org/10.15288%2Fjsad.2011.72.567

Romano, E., Voas, R. B., & Camp, B. (2017). Cannabis and cash responsibility while driving below the alcohol per se legal limit. *Accident Analysis and Prevention*, *108*, 37-43. http://dx.doi.org/10.1016/j.aap.2017.08.003

Rookey, B. D. (2012). Drunk driving in the United States: An examination of informal and formal factors to explain variation in DUI enforcement across U.S. counties. *Western Criminology Review*, *13*(1), 37-52. https://www.westerncriminology.org/documents/WCR/v13n1/Rookey.pdf

Schaffer, H. J., Nelson, S. E., LaPlante, D. A., LaBrie, R. A., Albanese, M., & Caro, G. (2007). The epidemiology of psychiatric disorders among repeat DUI offenders accepting a treatment-sentencing option. *Journal of Consulting and Clinical Psychology, 75*(5), 795–804. https://doi.org/10.1037/0022-006X.75.5.795

South, A. (2020, March 31). *Franklin county placed under stay-at-home order due to coronavirus; case tally at 19*. Public Opinion. https://www.publicopiniononline.com/story/news/local/2020/03/31/coronavirus-pa-franklin-county-added-stay-home-order/5095993002/

Stringer, R. J. (2018). Policing the drunk driving problem: A longitudinal examination of DUI enforcement and alcohol related crashes in the U.S. (1985-2015). *American Journal of Criminal Justice*, *44*, 474-498. https://doi.org/10.1007/s12103-018-9464-4

Stringer, R. J. (2021). Deterring the drunk driver: An examination of conditional deterrence and self-reported drunk driving. *Crime & Delinquency*. https://doi.org/10.1177/00111287211054721

Substance Abuse and Mental Health Services Administration (SAMHSA). 2020 NSDUH Detailed Tables. Rockville, MD: U.S. Department of Health and Human Services. January 2022.

Tri-State Alert (August 14, 2023). *Expect a DUI checkpoint sometime this month in Franklin County*. Retrieved January 30, 2024, from https://tristatealert.com/expect-a-dui-checkpoint-sometime-this-month-in-franklin-county/

University of Toledo. (n.d.). *Counseling Center: Blood alcohol content*. Retrieved March 28, 2024, from https://www.utoledo.edu/studentaffairs/counseling/selfhelp/substanceuse/bac.html

Wagenaar, A. C., Maldonado-Molina, M. M., Erickson, D. J., Ma, L., Tobler, A. L., & Komro, K. A. (2007). General deterrence effects of U.S. statutory DUI fine and jail penalties: Long-term follow-up in 32 states. *Accident Analysis & Prevention*, *39*(5), 982-994. https://doi.org/10.1016/j.aap.2007.01.003

Wang, S., Chen, Y., Huang, J., Liu, Z., Li, J., & Ma, J. (2020). Spatial relationship between alcohol outlet densities and drunk driving crashes: An empirical study of Tianjin in China. *Journal of Safety Research*, *74*, 17-25. https://doi.org/10.1016/j.jsr.2020.04.011

Ward, A. (March 5, 2024). *What U.S. states accept out of state medical marijuana cards? (Updated for 2024)*. Retrieved March 26, 2024, from https://www.nuggmd.com/blog/which-states-accept-out-of-state-medical-marijuana-cards

Watson-Brown, N., Truelove, V., Parker, E., & Davey, J. (2021). Drink driving during the COVID-19 pandemic. *Transportation Research Part F: Traffic Psychology and Behaviour*, *78*, 369-380. https://doi.org/10.1016/j.trf.2021.02.020

Wrigley, V. R., & Schumacher, T. (2023). Effects of pretrial detention length on sentencing guideline departures in two Pennsylvania counties. *Criminology, Criminal Justice, Law & Society*, *24*(3), 11-33. https://doi.org/10.54555/CCJLS.8495.90808