

Cannabis Use Among Drivers in Fatal Crashes in Washington State Before and After Legalization

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Washington State Initiative 502 (I-502), effective Dec. 6, 2012, legalized possession of small amounts of cannabis for recreational use by adults aged 21 years and older. It also included a prohibition against driving with 5 or more nanograms of delta-9-tetrahydrocannabinol (THC) per milliliter of blood, along with a zero tolerance prohibition for drivers younger than 21 years of age. THC is the main psychoactive component in cannabis and detection of THC in blood is suggestive of recent use. A previous study by the AAA Foundation for Traffic Safety examined data from drivers involved in fatal crashes in Washington State in years 2010-2014 and estimated that the proportion of drivers with detectable THC approximately doubled several months after I-502 became effective (Tefft et al., 2016). The research reported here updates the previous study with three additional years of data, post-legalization. Multiple imputation was used to estimate the proportion of drivers who were THC-positive among those who were not tested for drugs or whose test results were unavailable. Results indicate that five years after I-502, the proportion of fatal-crash-involved drivers who are THC-positive has remained approximately double the level observed before I-502. An estimated 21% of all drivers involved in fatal crashes in Washington State in 2017 were THC-positive, higher than in any other year in the 10-year period examined.

METHODS

Data on all drivers involved in fatal crashes in the state of Washington from 2008 through 2017 were obtained from the Washington Traffic Safety Commission (WTSC). The data included detailed information regarding whether each driver was tested for drugs, what type of specimen was tested (e.g., urine, blood, both, neither), and what drugs, if any, returned a positive test result. The WTSC abstracted detailed data from the original toxicology reports regarding the presence and concentration of THC and appended it to the data file.

The current study examined whether each driver whose blood was tested for drugs returned a positive test result for THC. A driver was considered:

- THC-positive if their blood was tested and a positive result for THC was reported;
- THC-negative if their blood was tested and a positive result for THC was not reported OR if urine rather than blood was tested for drugs and was not reported positive for any cannabinoids (a THC-positive driver would be expected to return positive

results for other metabolites of cannabis in a urine specimen);

- THC-unknown if they were not tested for drugs, if the specimen tested was urine rather than blood (because THC cannot be detected reliably in urine), or if positive results were reported for three drugs that rank higher than cannabinoids in the hierarchy of reporting (because the report form used during the study period could only accommodate a maximum of three positive drug test results).

The method of multiple imputation was used to estimate the proportion of THC-unknown drivers who were positive for THC. The imputation method and its rationale are described in detail in the previous report (Tefft et al., 2016); only changes to the method are described here. The inclusion of an additional five years of data made it possible to model the probability that a driver was tested for drugs and the probability that the driver was positive for THC at a more granular level. Specifically, the current study included in the prediction model for THC (i) a linear trend over the study period, (ii) a binary indicator

for whether the crash occurred before or after I-502 took effect, (iii) interaction of i and ii to model change in the slope of the trend, as well as (iv) age-specific, sex-specific, and urban/rural-specific trends and changes post I-502. Estimates for overlapping years differ slightly from those reported previously due to enhancements described above as well as the inclusion of additional data.

As in the previous study, 10 independent copies of the data set were created, each containing drivers’ actual THC test results if available and imputed values otherwise. Study results were produced by computing the statistic of interest in each of the 10 data sets individually and then averaging them.

RESULTS

There were 6,721 drivers involved in fatal crashes over the study period. The proportions of drivers who were tested for drugs varied by survival status and year. An average of 88% of drivers who died, but only 29% of surviving drivers, were tested for drugs each year. As shown in Table 1, a substantial proportion of drivers who died had only urine specimens tested in the early years of the study period; however, virtually all fatally-injured drivers who were tested for drugs after 2012 had blood specimens tested.

based on multiple imputation. The raw number of fatal-crash-involved drivers in the state of Washington who tested positive for THC more than tripled from five years before I-502 took effect through five years after. After inclusion of those not tested for drugs but imputed THC-positive, the estimated total number of THC-positive drivers involved in fatal crashes each year nearly tripled over the 10-year period as well. This reflects both an increase in the total number of fatal crashes statewide (including those not involving THC) and an increase in the proportion of drivers in fatal crashes who were THC-positive.

Table 2 shows the number of drivers in fatal crashes who tested positive for THC as well as the number of those without blood test results who were estimated THC-positive

Table 1. Drug Test Status and Specimen Type, by Survival Status and Year, Drivers Involved in Fatal Crashes, Washington State, 2008-2017.

| Year | Survived | | | | | Died | | | | |
|------------------|---------------|---------------|------------|-----------|--------------|---------------|---------------|------------|-----------|--------------|
| | Tested, Blood | Tested, Urine | Not Tested | Unknown | N | Tested, Blood | Tested, Urine | Not Tested | Unkown | N |
| 2008 | 20% | 3% | 76% | 1% | 355 | 54% | 37% | 8% | 1% | 354 |
| 2009 | 27% | 3% | 63% | 6% | 327 | 58% | 31% | 7% | 5% | 306 |
| 2010 | 36% | 1% | 62% | 1% | 328 | 56% | 32% | 5% | 7% | 291 |
| 2011 | 31% | 0% | 66% | 2% | 315 | 49% | 35% | 4% | 12% | 291 |
| 2012 | 33% | 0% | 66% | 2% | 319 | 65% | 24% | 5% | 7% | 272 |
| 2013 | 36% | 0% | 62% | 2% | 321 | 92% | 3% | 4% | 1% | 271 |
| 2014 | 31% | 0% | 68% | 1% | 334 | 81% | 1% | 17% | 1% | 289 |
| 2015 | 25% | 0% | 74% | 1% | 432 | 86% | 0% | 14% | 0% | 335 |
| 2016 | 29% | 0% | 71% | 0% | 441 | 89% | 0% | 11% | 0% | 326 |
| 2017 | 17% | 0% | 79% | 4% | 454 | 89% | 0% | 11% | 0% | 360 |
| All Years | 28% | 1% | 69% | 2% | 3,626 | 72% | 16% | 9% | 3% | 3,095 |

Note: Category *blood* includes all drivers for whom a blood specimen was tested for drugs, irrespective of whether urine was also tested. Category *urine* indicates that the only specimen tested was urine.

Table 2. Number of Drivers Who Tested Positive for THC and Number Estimated THC-Positive Based on Multiple Imputation, Drivers Involved in Fatal Crashes, Washington State, 2008–2017.

| | Actual THC-positive | Imputed THC-positive | Actual+Imputed THC-positive | |
|------|---------------------|----------------------|-----------------------------|-------------|
| | N | N | N | (95% CI) |
| 2008 | 32 | 29 | 61 | (44 - 79) |
| 2009 | 25 | 32 | 57 | (38 - 76) |
| 2010 | 36 | 22 | 58 | (43 - 73) |
| 2011 | 32 | 21 | 53 | (38 - 68) |
| 2012 | 36 | 16 | 52 | (37 - 67) |
| 2013 | 38 | 45 | 83 | (61 - 104) |
| 2014 | 74 | 40 | 114 | (89 - 139) |
| 2015 | 82 | 53 | 135 | (112 - 158) |
| 2016 | 94 | 50 | 144 | (118 - 170) |
| 2017 | 101 | 73 | 174 | (148 - 200) |

Figure 1 shows the estimated percentage of all drivers involved in fatal crashes each year in Washington State who were THC-positive, based on both actual test results and multiple imputation of missing values. Before I-502 became effective, an average of 8.8% of all drivers in fatal crashes statewide each year were THC-positive. After I-502 became effective, this increased to an average of 18.0%. The increase was not immediate – it appears that the increase occurred gradually throughout 2013 before reaching a relatively stable post-I-502 level in 2014. Data from 2015 through 2017 appear to be suggestive of a continued slight increasing trend in the proportion of fatal-crash-involved drivers who are THC-positive, however, it is unclear at this point whether this is attributable to random fluctuation, uncertainty in the imputed values, or whether the proportion is continuing to trend upward.

DISCUSSION

A previous study by the AAA Foundation for Traffic Safety estimated that the proportion of drivers in fatal crashes in the state of Washington who had detectable THC in their blood at or shortly after the time of the crash approximately doubled after I-502 became effective Dec. 6, 2012, effectively legalizing possession and use of small amounts of cannabis in the state for adults aged 21 years and older (Tefft et al., 2016). At that time, the most recent data available were from year 2014, and it was unclear whether the large increase in the involvement of THC-positive drivers was temporary and would return to previous levels, whether the percentage would stabilize around the level seen in 2014, or whether it would continue to increase even further. The current study updates that previous study with an additional three years of data after I-502 became effective. Generally, results suggest that the proportion of fatal-crash-involved drivers who are THC-positive in the state appears to have stabilized, at about twice the prevailing level prior to I-502. Both the proportion of drug-tested drivers who tested positive for THC (26%) and the estimated proportion of all drivers who were THC-positive (21%) reached their highest levels of the entire 10-year study period in 2017.

The current study considers the presence of detectable THC in the blood of fatal-crash-involved drivers. In general, the presence of detectable THC in blood suggests, but does not conclusively prove, that a person has recently used cannabis. THC blood levels and impairment are not well-correlated. THC levels in blood peak shortly after cannabis is smoked, and then they decline substantially by the time of peak impairment, which generally occurs approximately 90 minutes after consumption (Compton, 2017). Any acute impairing effects of THC typically subside within about 2-3.5 hours (but in some cases up to six hours) after smoking. While occasional users of cannabis may no longer have detectable levels of THC in their blood by this time, frequent users may still have relatively high concentrations of THC in their blood well beyond the period of acute impairment (Arnold et al., 2019). Studies have found blood THC concentrations exceeding Washington’s 5 nanogram per milliliter per se limit as long as 24 hours after a frequent cannabis user last used cannabis (Desrosiers et al., 2014). Others have found THC in the blood as long as 30 days after having last used cannabis (Bergamaschi et al., 2013).

The current study and that which it updates (Tefft et al., 2016) are distinguished by the use of blood test results and the method of multiple imputation for drivers with missing test results to examine the effects of recreational cannabis legalization on the proportion of THC-positive drivers involved in fatal crashes. Other studies have considered the effects of legalization on traffic safety in Washington and other states utilizing a variety of metrics such as the overall number or rate of crashes or deaths (i.e., irrespective of cannabis involvement in any particular crash), with varying results. A study examining fatal crash rates in Washington and Colorado (where recreational cannabis use was also legalized in December 2012) estimated an increase of 1.2 fatal crashes per billion vehicle miles traveled post-legalization relative to control states, and an increase of 1.8 fatal crashes per billion vehicle miles traveled after retail sales of cannabis began in 2014 relative to before legalization (Aydelotte et al., 2019). A 2017 study by the Highway Loss Data Institute found that the legalization of retail sales in Washington, Colorado, and Oregon was associated with increased collision claim frequencies relative to control states without legalized recreational cannabis. A subsequent update using an additional year of claims

data found collision claim frequencies increased by 9.7% in Washington and by 12.5% in Colorado relative to control states. However, the change in claim frequency in Oregon was smaller and not distinguishable from chance variation in the data (Highway Loss Data Institute, 2018). A similar study by Monfort (2018) estimated that retail sales of cannabis were associated with a 5.2% increase in the rate of police-reported crashes in the three states with legalized recreational cannabis relative to neighboring control states, though results were mixed when each state was examined individually.

This study is subject to limitations, which are explained in greater detail in the previous study which this study updates (Tefft et al., 2016). Due to the rapid decrease in blood THC levels shortly after cannabis is smoked, and the typical delays in collecting specimens after a crash, some drivers who tested negative for THC may have actually had THC in their system at the time of the crash. Relatedly, while testing positive for THC in blood is suggestive of recent cannabis use, it is possible for a person to have a detectable concentration of THC in their blood days after having last used cannabis, particularly among frequent cannabis users. Furthermore, drivers that tested positive

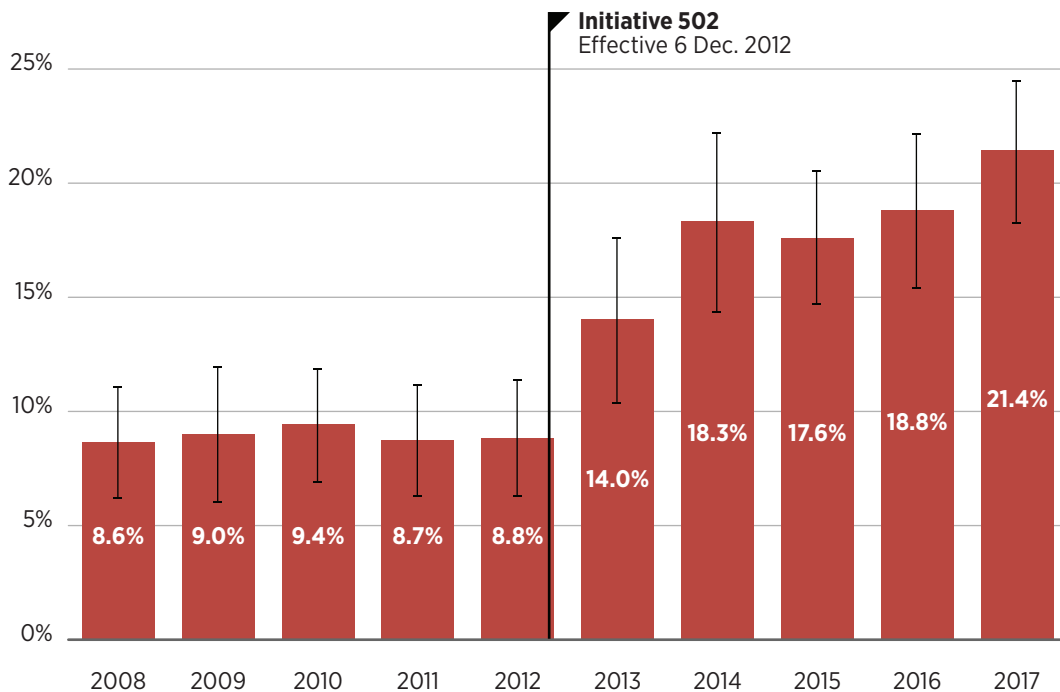


Figure 1. Estimated Percentage of Drivers Involved in Fatal Crashes Who Were THC-Positive, Washington State, 2008-2017.

Vertical bars represent 95% Confidence Intervals.

were not necessarily impaired; depending on a variety of factors, they may or may not have been experiencing acute or residual impairment. THC-positive drivers were not necessarily at fault for their crashes; this study did not examine fault for crashes at all. Although the multiple imputation model used to impute the THC values of drivers not tested for drugs performed well in validation tests, it is possible that other factors not accounted for in the model might be correlated with both the probability that a driver was tested for drugs and with whether the driver had detectable THC in their blood. In this scenario, some degree of bias could be present in the imputed results.

In conclusion, the results of this study indicate that the previously-documented doubling of the prevalence of THC-positive drivers in fatal crashes in the state of Washington subsequent to the legalization of recreational cannabis has been sustained at least through 2017. Currently, the data contain too much variability to conclude confidently whether the prevalence of THC-positive drivers in fatal crashes is continuing to increase, however, it was greater in 2017 than in any of the prior years examined. More research is needed to understand the role of cannabis in motor vehicle crashes and fatalities and the impact of regulations.

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