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February 21, 2017

TESTIMONY REGARDING SB301

Chair Prozanski and Committee Members:

When we had the opportunity recently to meet with many of you we discussed impairment testing as a logical alternative to urinalysis testing. As you may be aware, the OLCC has recently reported to the Legislature, in the context of the DUII law, that neither the science, nor the technology supports a *per se* DUII limit. OLCC's report is available online here:
http://www.oregon.gov/olcc/marijuana/Documents/HB3400_2015_DUIILegislativeReport.pdf
and attached to this testimony. In fact, the Oregon State Police are on record as saying that, except in injury or death cases, urinalysis testing is of little evidentiary value.

We also discussed with some of you the availability of a phone app to test impairment.
http://www.mycanaryapp.com/
(click on Science)
and attached to this testimony. Although this is not a perfect fit for DUII, by providing a baseline test as a part of the hiring process, it would fit with impairment testing in the employment context.

Lastly, we are aware that some folks are concerned that this bill is contrary to Measure 91's assurance that nothing in that initiative would change employment laws. And, as with Legislative changes to the Medical Marijuana Act and automatic referenda when a municipality opts out, nothing in Measure 91 changed these either. However, neither the Legislature, nor the people, acting as a co-extensive branch of the Legislature under Article IV of our state constitution can bind a later legislative session from amending the law.

Here, we have the opportunity to end employment discrimination against cannabis consumers *qua* consumers. We very much appreciate this public hearing, and would be glad to answer any questions you may have.

My Canary Mobile Phone Based Human Performance App

The Science

My Canary is a mobile phone based human performance app designed to detect changes in human performance.

To design My Canary we examined thousands of peer-reviewed studies on the influence of fatigue, and legal and illegal substances, including NASA, NHTSA, and DOD research. In addition we reviewed over 20,000 studies specifically focusing on the influence of marijuana on functioning.

The result of this research was the development of four highly sensitive cognitive and psychomotor tests designed to detect even subtle changes in performance resulting from fatigue, medication, alcohol, and marijuana use. By combining these tests into an overall performance score, and allowing users to establish their own performance baseline for these tests, My Canary is able to accurately detect significant changes in overall performance.

Detecting changes in overall performance answers the question, “Are you performing at your best?”

The four tests measure and record:

- Memory
- Balance
- Reaction Time and Divided Attention
- Time Perception

Below is a review of the science on which these tests are based.

Memory Test

The capacity to perform complex tasks depends critically on the ability to retain task-relevant information in an accessible state over time (working memory) and to selectively process information in the environment (attention). As one example, consider driving a car in an unfamiliar city. In order to get to your destination, directions have to be retained and kept in working memory. In addition, one must be able to selectively attend to the relevant objects because there is more information in a scene than can be processed by our perceptual systems. In fact, the contents of working memory and attention often overlap. If the directions stored in working memory instruct you to “turn left after the yellow water tower,” then attention may be guided towards objects that resemble a yellow water tower. [(XXXI)]

Working memory is a key cognitive function that allows individuals to hold information in mind, while at the same time manipulating the same or other information. For example, multi-tasking requires working memory because a person must be aware of numerous activities simultaneously. Likewise, multiplying two large numbers in your head requires the use of working memory. Consequently, working memory capacity is commonly measured by determining how many items a person can remember simultaneously for a short period of time. Someone who can remember all 10 digits of a phone number and repeat them back has a greater working memory capacity than someone who can only recall four.

Digit string memory has been extensively studied by psychologists and neuroscientist. The pertinent memory process involves the "verbal working memory." This is commonly referred to as the "phonological loop." It is a combination of verbal storage and a rehearsal system used to remember the digit string.

Traditionally, the capacity of the working memory is measured by asking subjects to remember a list of items and then counting how many they can repeat. This is a standard subtest in many intelligence tests, e.g. the WAIS (Wechsler Adult Intelligence Scales). The average capacity for remembering letters or numbers has been shown to be 7 +/- 2. Different experiments find different numbers, but they all range between 3 and 9.

Changes in the brain that affect memory, cognitive functioning, and the control of body actions eventually affect driving ability. [XXXII]

Balance Test

Data from numerous laboratory studies which have examined balance as an isolated topic indicate that changes in balance and coordination impacts the capacity to perform complex psychomotor tasks. [XXXVI]

Even when mildly present, common symptoms such as shaking in the arms, hands, or legs; impaired balance; and slowed physical and mental responses can affect driving skills. [XXXVII]

Driving is a complex skill, and balance provides a clue, although may not be specifically required to drive safely. Our ability to drive safely can be challenged by and changed by our physical, emotional and mental condition. [XXXVIII]

Reaction Time and Divided Attention Test

A useful definition of reaction time in driving studies means “the time it takes to react to an emergency, whether by hitting the brakes, turning the wheel, or by otherwise responding.”

Normal simple reaction time does not account for the decision component required by road reaction demands. In addition to reacting to an emergency physiologically, additional time is needed to evaluate the situation, consider the options, and act on the decision. Of course this sequence is quite rapid, but at 60 mph, even “quite rapid” takes large distances in real life. This specific type of reaction time is frequently referred to as the "perception-reaction time" in traffic engineering literature. This is a critical foundational concept in My Canary. Perception Reaction Time is a critical factor in measuring and predicting performance. It is this PRT that is relevant to total stopping time/distance while driving. [XXXIX]

My Canary accounts for Perceived Reaction Time (PRT). If you are a professional athlete for example, your baseline will be based upon YOUR reaction time, as determined when you set your baseline. Perhaps for the pro batter who can watch the seams on a baseball as it leaves the pitcher's hand, normal reaction time is 0.5 seconds; substantially faster than for most people.

Driver reaction time is one of the most important factors identified in crash avoidance research.[XLII]

A simple relationship was found between plasma THC and behavioral decrement in both tracking under divided attention and in critical tracking. A significant correlation between tracking errors and divided attention and TCH plasma levels has been demonstrated experimentally. [XLIII]

My Canary exploits the critical diagnostic aspects of reaction time and PRT variation in the design of the algorithms applied to the raw test data. The underlying body of research, including crash-avoidance research is incorporated.

Time Perception Test

Cannabinoids have been shown to alter time perception. This refers to the subject's personal subjective experience of the passage of time. This is the "it seemed like forever" type of effect. The existing literature has several limitations. Few studies have included both time estimation and production tasks, and few control for sub-vocal counting, although the SFST's and My Canary instruct counting aloud. Most of these studies had small sample sizes. Some did not record a subjects' cannabis use, many tested only one dose, and used either oral or inhaled administration of Δ^9-tetrahydrocannabinol (the primary psychoactive cannabinoid in marijuana, generally referred to as THC), leading to variable pharmacokinetics. Some of the studies used whole-plant cannabis containing cannabinoids other than THC. Cannabis contains 483 compounds. At least 80 of these are cannabinoids Combustion adds another 100 or so chemicals to the concoction.[XLIX]

A psychoactive dose of THC increases internal clock speed as indicated by time overestimation and underproduction. This effect is not dose-related, and is blunted in chronic cannabis smokers, who did not otherwise have altered baseline time perception. [XLIV]

Official NHTSA Standard Field Sobriety Test validation studies, manuals, and other publications confirm SFST's do not indentify impairment. "Driving a motor vehicle is a very complex activity that involves a wide variety of tasks and operator capabilities. It is unlikely that complex human performance, such as that required to safely drive an automobile, can be measured at roadside."[LI]

This is true of the SFST's, and is true of My Canary. What is new, improved, and of far greater utility and reliability are the methods of taking the measurements, the way that the various inputs are analyzed and interpreted, and the objective consistency of the measurements obtained by My Canary, combined with the ability to create personal performance baselines. While not resolving every failing in the SFST approach, My Canary does advance the ball considerably.

The Importance of an Individual Baseline

My Canary is designed for an individual to establish a personal “baseline” (their own performance profile). This is valuable since all individuals vary to some degree. For example, “normal” reaction time is approximately 0.75 seconds, but many people are above and below that “norm.” Establishing a personal baseline ensures that each individual’s performance is compared with themselves and no one else. Once a baseline is established it can be used anytime.

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House Bill 3400
DUII Legislative Report

Oregon Liquor Control Commission

January 1, 2017

Contents

Executive Summary

During the 2015 Regular Session of the Oregon Legislature House Bill 3400 was signed into law and tasked the Oregon Liquor Control Commission, the agency responsible for regulating the recreational marijuana market in Oregon, with studying the question of THC-related intoxicated driving. While Colorado and Washington, the first states to legalize recreational marijuana, instituted a *per se* THC blood concentration limit of 5 ng/ml, Oregon did not. Instead, Oregon relies on evaluations by Drug Recognition Experts (DRE) to assess drivers for intoxication if they have already passed a breathalyzer test (i.e. have blood alcohol content below 0.08).

Among teens, attitudes towards driving after marijuana use is significantly more relaxed than in regards to alcohol. Nationally, since 2001 driving under the Influence of THC by high school seniors has increased even as drunk driving has decreased.[1] In Oregon, while alcohol use is higher than marijuana use among 8th and 11th graders, driving after using marijuana is considerably more common than in the case of alcohol.[2]

Data related to any potential effect of legalization on the incidence of THC-intoxicated driving is extremely limited for several reasons. First, the data that currently exists does not cover a sufficient amount of time post-legalization due to the timeline of implementation. Second, significantly fewer drivers involved in fatal accidents in Oregon are tested for drugs than in other legalization states. However, the data that does exist does not indicate an epidemic of THC-related collisions. The rate of drivers tested by Drug Recognition Experts who are positive for THC intoxication rose between 2013 and 2014, but did not increase following legalization. Fatal accidents data is highly variable year-to-year, making trend analysis difficult. But in Oregon in 2015 there were only three more traffic fatalities involving a driver testing positive for THC compared to 2004. Moreover, the rate of THC-related fatal accidents is also considerably lower than such accidents involving alcohol intoxication. Finally, while overall traffic fatalities and alcohol-related fatalities spiked in 2015, THC-related fatalities did not.

Differences in how the body processes marijuana as compared to alcohol makes accurate detection of THC concentration and its intoxicating effect significantly more difficult. It is especially difficult to detect recent use of marijuana in the field. While current research overall shows a lower risk associated with THC-intoxicated driving, this research is relatively new and less robust than similar research related to alcohol.

Given the existing data and body of research, the institution of a *per se* standard for THC intoxication may not be warranted. However, there are five steps the state could take to mitigate the risk of THC-related intoxicated driving that does occur while working to more fully understand its risk and prevalence.

1) **Increase Public Education of Risks of Marijuana and Driving, Particularly Among Teens**
   Among teens, driving after marijuana use is considerably more common than driving after alcohol use. While the “Stay True to You” public education campaign recently launched by Oregon Health Authority focuses on decreasing the propensity of marijuana use among teens, no campaign in Oregon exists that focuses on the issue of marijuana-intoxicated driving specifically. A public education campaign focused on the intoxicating effects of marijuana and the dangers of impaired driving could be a useful tool in changing such attitudes.

2) **Expand Oregon's Drug Recognition Expert program**
An expansion of the program could reduce wait times for DREs to be deployed and lower the strain on local resources. This would increase the likelihood that DRE evaluations are requested when probable cause for THC intoxication exists.

3) **Field Test Oral Swab Detection**
Implementing oral swab testing on a pilot basis where driver's consent is granted could increase the scope of data collection beyond what is possible with DRE evaluations alone. Such a pilot could also provide data on the cost effectiveness of various approaches in detecting recent use of marijuana and intoxication.

4) **More Comprehensive Data Collection**
Existing data related to accidents and traffic stops where intoxication is involved is sparse, disparate, and incomplete. Evaluations for THC only occur when the driver does not have a 0.08 or greater BAC, despite evidence that the interaction of alcohol and THC is uniquely intoxicating. Drivers involved in fatal accidents are tested for drugs at far lower rates than other legalization states. Moreover, data is decentralized depending on the agency or jurisdiction evaluating the driver. The collection and centralization of more complete data in both fatal and non-fatal accidents could facilitate policy-making decisions in the future.

5) **Further Research into Detection Technology and Crash Risk**
For a *per se* standard for THC to be established equivalent to the 0.08 BAC standard, two specific areas of research need to be more fully developed. First, standardized field detection tools must be created and tested that are able to detect *recent use* and *impairment*, separate from levels of THC that may be due to chronic but non-recent marijuana use. Second, research must be conducted to isolate the dose-response relationship of THC and impairment. Higher education institutions in California and the province of British Columbia have already embarked on this type of research. Oregon could utilize existing efforts (creation of a cannabis research institute and OLCC-licensed research certificates) to encourage research on public health areas such as THC-related DUII.

A significant change in status quo policy or the institution a *per se* intoxication standard for THC may not be warranted at this time. Instead, recommendations in this report aim to find avenues to change attitudes towards THC and driving among youth, increase the quality and availability of data, and strengthen the body of research.

Background

When Colorado and Washington legalized recreational marijuana in 2012, the first states to do so, they instituted *per se* limits of delta-9-tetrahydrocarbonal (hereafter *THC*) while driving. As with an alcohol blood alcohol concentration (hereafter *BAC*) of 0.08, a *per se* THC limit dictates that a concentration of THC above a certain threshold is on its own legally sufficient to prove and prosecute for impaired driving. In Colorado and Washington, this *per se* threshold was 5 nanograms of THC per milliliter of blood (ng/ml).[3] Although Colorado ultimately selected 5 ng/ml as the *per se* limit in 2013, an earlier task force in 2011 showed wide variability in expert opinion regarding at what level a *per se* limit should be placed.[4]

Oregon's recreational legalization law, Measure 91, which was approved by Oregon voters in November 2014, did not include any *per se* limit of THC intoxication. Rather, Oregon utilizes Drug Recognition Experts around the state to determine whether a driver suspected of intoxication but not positive for alcohol (i.e. below the 0.08 BAC threshold) is likely to be under the influence of another intoxicant, such as THC.[5] This evaluation procedure, rather than a specific THC blood concentration, is used to prosecute DUII cases in a court of law.

During the 2015 Regular Session of the Oregon Legislature House Bill 3400 was signed into law and tasked the Oregon Liquor Control Commission, the agency responsible for regulating the recreational marijuana market in Oregon, with studying the question of THC-related intoxicated driving. Specifically, the law states that:

> On or before January 1, 2017, the Oregon Liquor Control Commission:
> (1) Shall examine available research, and may conduct or commission new research, to investigate the influence of marijuana on the ability of a person to drive a vehicle and on the concentration of delta-9-tetrahydrocannabinol in a person's blood, in each case taking into account all relevant factors; and
> (2) In the manner provided by ORS 192.245, shall present the results of the research, including any recommendations for legislation, to the interim committees of the Legislative Assembly related to judiciary.

This report will first review the data regarding intoxicated driving prior to and following legalization in Oregon; review the differences between alcohol and THC and their respective effects on driving ability, methods of detection and relative risk of injury or fatality associated with each; and make recommendations for further action to mitigate the risk of THC-related intoxicated driving.

Trends in THC-related DUII

Data in Oregon is significantly lacking when it comes to THC-related Driving Under the Influence of Intoxicants (DUII). Largely due to the fact that drivers are only evaluated for THC intoxication if they are suspected of intoxication, are below a 0.08 BAC threshold, and are examined by a Drug Recognition Expert (DRE), it is likely that many intoxicated drivers are not detected for one reason or another. Moreover, the time it takes to complete a DRE exam and conduct a urine analysis (none of which occurs in the field) is significant. This time lag likely results in drivers who were intoxicated at the time they were pulled over no longer rising to a level of detectable or sufficient intoxication by the time the exam is completed and urine is collected.

Moreover, the timeline of implementation of marijuana legalization in marijuana makes it difficult to discern, given current data, to what degree legalization may or may not be affecting THC-related DUII. Although Measure 91 was passed by voters in November 2014, possession and consumption of marijuana did not become legal until July 1, 2015. Additionally, sales of recreational marijuana were not available until October 1, 2015. Given the lag times in collecting, reporting, and finalizing data, as of this report only limited data is available through the end of 2015 and data for 2016 remains preliminary. As such, these conclusions regarding THC-related DUII trends cannot wholly take into account potential effects of legalization.

Data related to the overall incidence of marijuana use and attitudes towards driving after use relies on self-reporting and population surveys. Due to public health concerns surrounding the effect of legalization on marijuana use by minors, researchers have focused on this population specifically. Nationally, since 2001 driving under the influence of THC by high school seniors has increased even as drunk driving has decreased.[6]

In Oregon, while alcohol use is higher than marijuana use among 8th and 11th graders, driving after using marijuana is considerably more common than in the case of alcohol. Among 11th graders, 30% had alcohol in the last 30 days compared to 20% using marijuana over the same time period. However, among the same students who drive, 48% of students who had used marijuana drove within three hours of use, compared to 12% of students who had drunk alcohol.[7] Separate from the impact of marijuana use on the risk of crashes, it is clear that youth attitudes towards driving after marijuana use is significantly more relaxed than in regards to alcohol.

In terms of actual incidents of THC-related intoxicated driving, two main sources of data exist. The first source is data from DRE evaluations – for example, number of evaluations conducted, drugs detected, demographics of drivers evaluated, etc. The second source is data from fatal accidents, which is collected by each state and reported annually to the National Traffic Safety Administration.

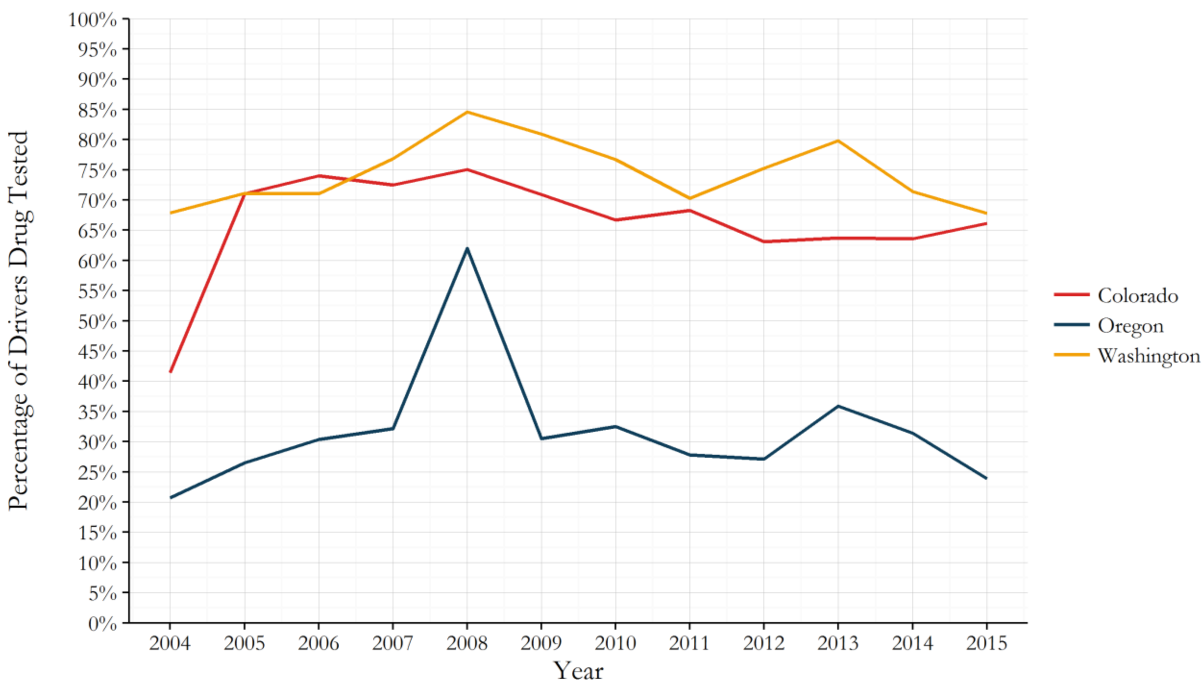
Each data source has major limitations related to the scope of data collection. In regards to DRE evaluations, the data collected is first and foremost gathered as a means of prosecuting offenders when DUII cases are pursued. Specifically, that means that when a subject tests positive for alcohol (i.e. BAC > 0.08), no DRE evaluation is conducted because there is sufficient evidence to prosecute the driver for a violation of the *per se* alcohol standard. While DRE evaluation data does include the driver's BAC where relevant, in all cases these BAC levels are below 0.08. This makes research into the incidence of and risk from mixing alcohol and marijuana extremely difficult.

In regards to fatal accident data, the major limitation is the percentage of drivers tested for THC intoxication. Although ORS 146.113 requires examination by the medical examiner and testing for alcohol, controlled substances are only tested for if deemed necessary:

> "(2) When a death requiring an investigation as a result of a motor vehicle accident occurs within five hours after the accident and the deceased is over 13 years of age, a blood sample shall be taken and forwarded to an approved laboratory for analysis. Such blood or urine samples shall be analyzed for the presence and quantity of ethyl alcohol, and *if considered necessary by the State Medical Examiner, the presence of controlled substances*."
> [emphasis added]

This exception of testing for controlled substances only when deemed necessary has resulted in significantly fewer drivers involved in fatal crashes being tested for THC. Oregon's rate of testing such drivers for THC is significantly lower than in other legalization states (see Figure 1). For example, in 2014, Oregon tested approximately 30% of drivers involved in a fatal accident, compared to approximately 65% and 70% of drivers in Colorado and Washington, respectively. Although the relatively consistent rate of testing makes it possible to compare changes in intoxicated driving rates across years within Oregon, it makes it difficult, if not impossible, to accurately compare levels of intoxicated driving to these other states.

Figure 1: Percentage of drivers involved in fatal accidents tested for THC



Irrespective of the limited scope of the data, there are valuable insights each source provides. DRE evaluations, for example, are perhaps the best insight into non-fatal intoxicated driving. In 2015 approximately half of all drivers evaluated by a DRE tested positive for THC intoxication (see Figure 2).[8] Since 2013 this rate has risen considerably. The rate of positive THC results from toxicology reports based on samples taken from the same drivers has increased at the same rate since 2013, providing further evidence of an increase in THC-related impaired driving. Moreover, the number of DRE evaluations actually conducted since 2013 has also increased, although they remain lower than in 2011 (see Figure 3). It is possible that the increase in DRE evaluations is itself an indicator of more frequent THC-related intoxicated driving. A greater number of DRE evaluations indicates more instances of reasonable suspicion of intoxicated driving that cannot be explained by alcohol alone – in other words more drivers were suspected of intoxicated driving but had BAC less than 0.08. However, this rise in the number of evaluations is not itself determinative of a rise in THC-related DUII. The increase could also be due to greater attention being paid to the potential for THC-related intoxicated driving as a result of legalization, meaning more drivers were pulled over than otherwise would have been prior to legalization even if the circumstances were identical.

Figure 2: Percentage of Evaluations where DRE Opinion of Impairment Involved Cannabis, 2011–15

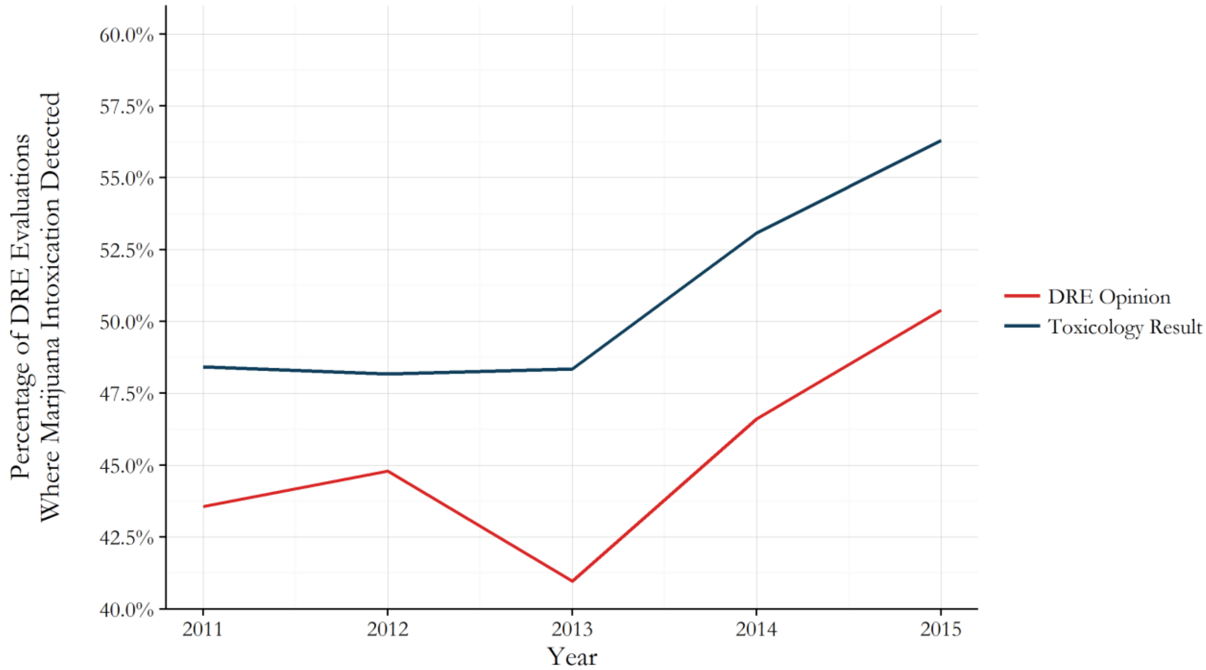
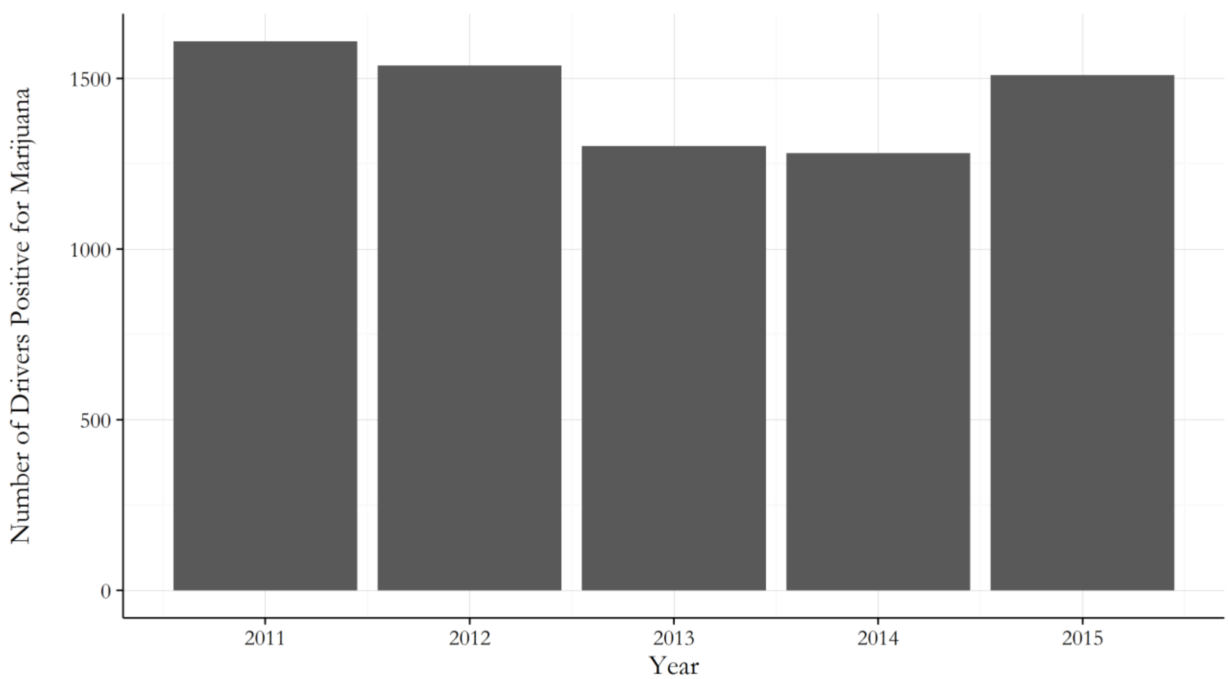
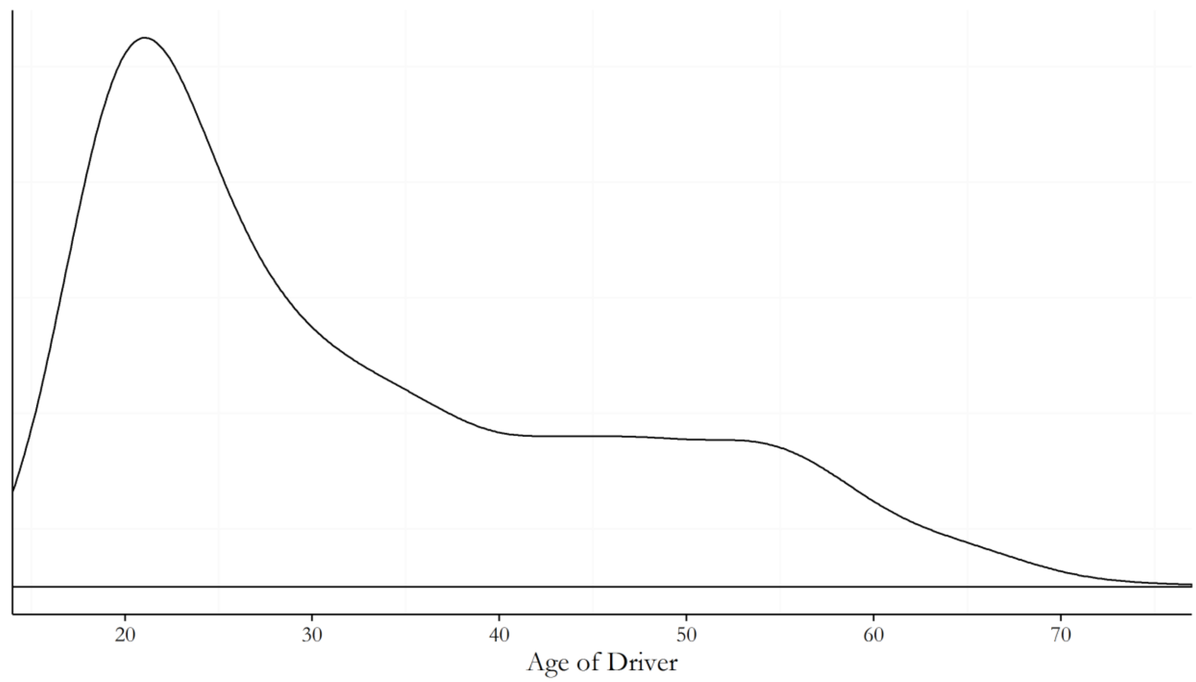


Figure 3: Number of DRE Evaluations Conducted, 2011–15



The demographic profile of the average driver testing positive for THC intoxication is a male in his early twenties who is not registered as an Oregon Medical Marijuana patient. Nearly 73% of THC-intoxicated drivers screened by DREs were male in 2013, and in 2015 78% were male.[9] Below, Figure 4 shows that the vast majority of THC-intoxicated drivers were in their early 20s, and between 2013 and 2015 the median age was 28. As discussed later in this report, such demographics make it difficult to isolate the risk of marijuana in relation to intoxicated driving, as males in their late teens and early 20s are higher risk drivers overall even in the absence of intoxicants.

Figure 4: Density Plot of Age of THC-Intoxicated Drivers Screened by DRE, 2013–15



The most reliable data for cross-state comparisons of THC-related DUII is the National Traffic Safety Administration's Fatality Analysis Reporting System (FARS).[10] FARS is annual data on all crashes on public roadways in the United States that resulted in a fatality of anyone involved in the death (e.g. driver, passenger, pedestrian, etc.) within 30 days of the crash.[11] The analysis that follows relies on the FARS microdata from 2004–2015.[12] FARS relies on reporting from individual states, and differences between states in terms of how and when testing for a battery of potential intoxicants (alcohol, THC, other drugs, etc.) is conducted could account for differences between states. As discussed above, Oregon has a substantially lower rate of testing than other states. However, FARS still represents the best data available for cross-state comparisons over time. Unless otherwise noted, the data presented below limits the analysis to only drivers that were tested for marijuana to isolate the risk specifically associated with driving under the influence of THC and to correct for different rates of testing drivers across states.

Since legalization in Colorado and Washington in 2012, the percentage of traffic fatalities involving a driver with a detectable limit of THC has increased significantly (see Figure 5). After an initial spike in Washington, the state saw a decrease in the rate in 2015 – a decrease that Oregon also experienced in its first (partial) year of legalization. The overall trend is more difficult to infer in Oregon due to significant variability year-to-year, but since 2013 Oregon has actually seen a higher relative increase compared to Washington, despite Washington's earlier legalization (see Figure 6). In summary, the data shows that Oregon's long-term trend of the rate of THC-related fatal accidents is relatively flat and lower than Washington but that the short-term trend is highly variable. Because of this high degree of variability, trends should be evaluated over a longer timeframe. It is too early to tell whether or how legalization in Oregon has affected fatal accidents.

Figure 5: THC-Intoxicated Drivers as Percentage of Fatal Crashes, 2004 – 2015

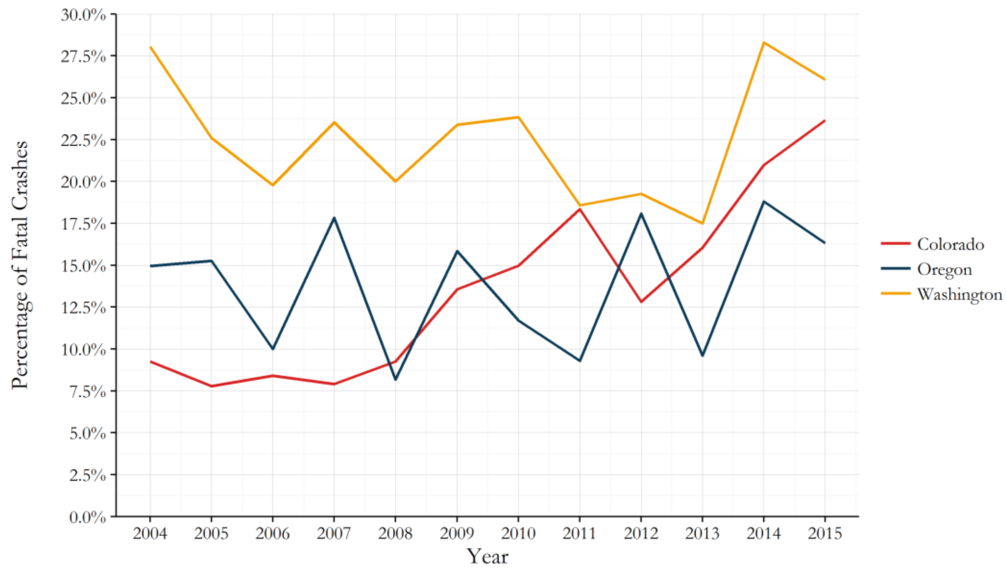
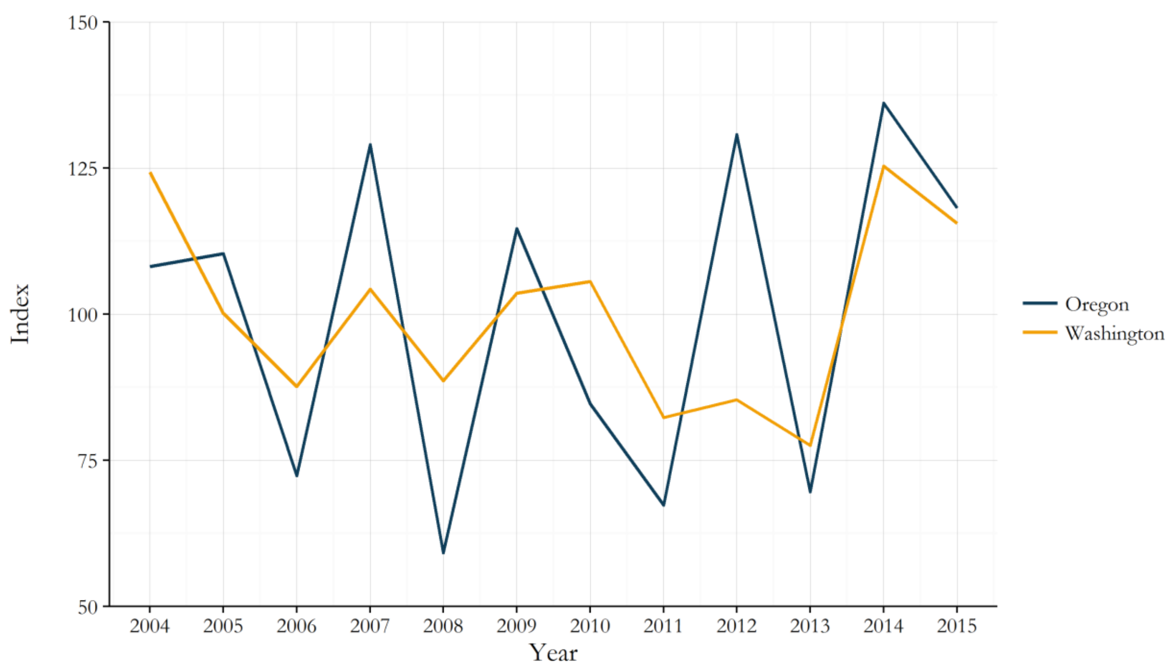
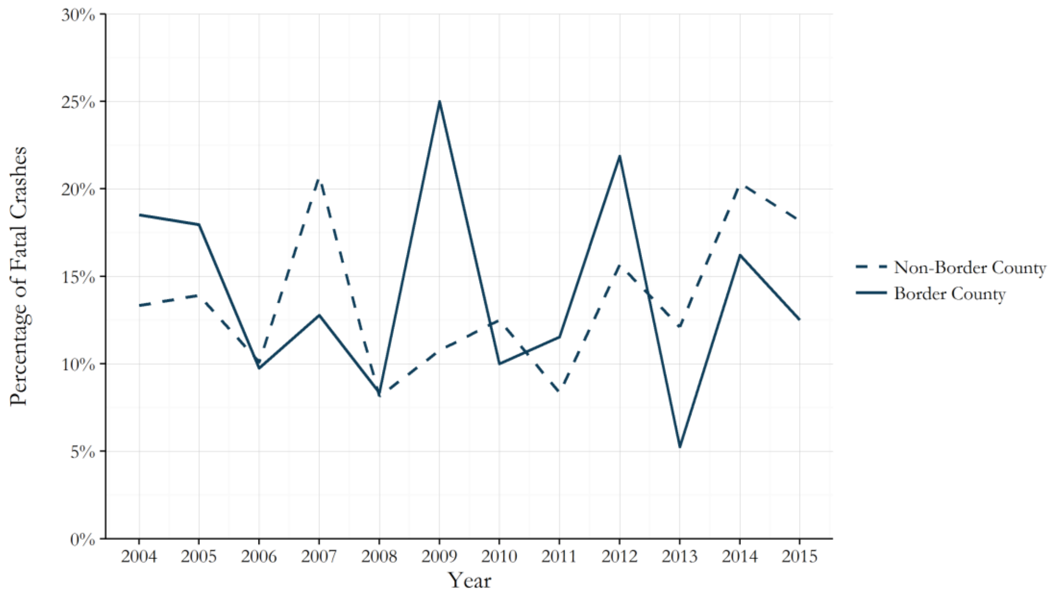


Figure 6: THC-Intoxicated Drivers as Percentage of Fatal Crashes, Oregon vs. Washington (100 = State 2004 – 2015 Average)



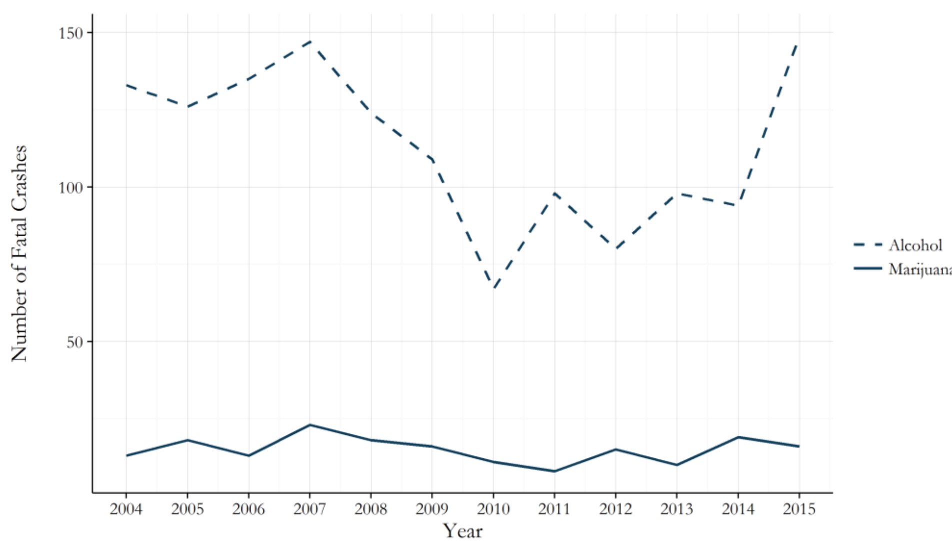
One potential reason that Oregon saw a rise in THC-related fatalities prior to legalization within its borders is a cross-border effect. When Washington legalized marijuana, a considerable amount of purchases in Southern Washington were by Oregon residents.[13] This border effect of purchases also could have translated into a border effect on intoxication rates. However, a comparison of fatal accidents in Oregon's border versus non-border counties (see Figure 7)[14] does not bear this out. Although the data is highly variable for border counties, the overall trend for non-border counties (those least likely to see an effect on driving incidents due to Washington legalization) show the more consistent increase.

Figure 7: THC-Intoxicated Drivers as Percentage of Fatal Crashes in Oregon, Border vs. Non-Border Counties



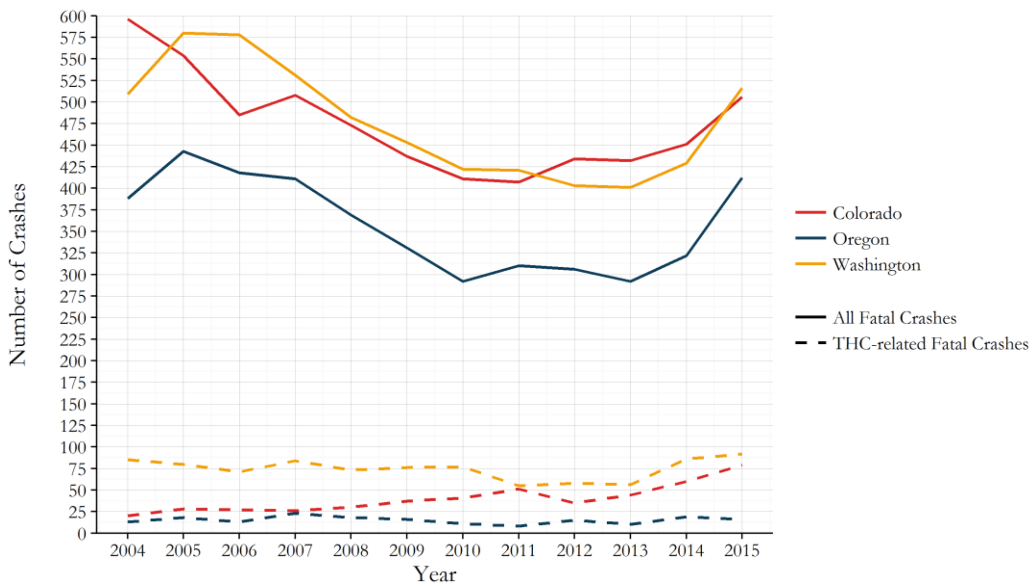
Comparing THC and alcohol intoxication of drivers in fatal crashes provides further perspective. While the above analyses look exclusively at drivers tested for drugs, the below analyses relies on data for all drivers in the FARS data. Five to ten times more drivers who were involved in fatal accidents in Oregon between 2004 and 2014 had alcohol in their system than THC (see Figure 8). As with THC intoxication, the overall trend of alcohol intoxication in fatal accidents has been an increase since 2010, although alcohol-related fatalities spiked significantly in 2015 while THC-related fatalities decreased slightly.

Figure 8: Number of Intoxicated Drivers Involved in Fatal Crashes by Type of Intoxication



It is also instructive to evaluate the total number of fatal crashes relative to the number of THC-related crashes rather than the rate of incidence. While the rate has increased since 2004 in Colorado, Washington, and Oregon, this is due in large part to the substantial decline of fatal accidents overall in that time (see Figure 9). For example, the number of incidents in Oregon rose by just three THC-related fatalities between 2004 and 2015 (from 13 to 16). In Washington, despite the dramatic increase in the rate between 2013 and 2014, the overall number of fatal accidents in Washington involving a THC-intoxicated driver was only seven more in 2015 than in 2004 (92 versus 85). Additionally, overall traffic fatalities increased substantially in all three states between 2014 and 2015 and cannot be explained by THC-related fatalities. This data illustrates that traffic fatalities overall remain a significant problem, independent of THC-related crashes.

Figure 9: Number of Fatal Crashes by State, 2004 – 2015



Overall, a review of the data regarding fatal accidents in Colorado, Washington, and Oregon since 2004 shows a mixed bag of results. The rate of THC-related traffic fatalities has risen considerably in Washington and Colorado since legalization in 2012. However, alcohol-related traffic fatalities in Oregon remain considerably higher than THC-related ones and spiked significantly in 2015. Finally, while the rate of THC-related fatalities has risen, this is in large part due to the decrease in the denominator (overall traffic fatalities). In short, while the data demonstrates that THC-intoxicated driving has been on the rise during the last few years, there is no evidence that it is an epidemic of THC-related collisions. Although it is too early to tell what effect full legalization in Oregon has had on THC-intoxicated driving, the data in 2015 shows that factors independent of marijuana, particularly alcohol intoxication, are likely to explain a more significant share of traffic fatalities even after legalization.

Metabolization of Alcohol and THC

One of the greatest distinctions between alcohol and THC is the ways each is metabolized. THC is fat soluble, alcohol is not. This means that alcohol is processed by the body and leaves at a predictable rate, whereas THC can be absorbed by fatty tissue and stored (and re-released into the body) for long periods of time. This absorption into fatty tissue creates a significantly longer half-life for THC in the body, greatly increasing the time after use during which it's detectable.[15] Moreover, *where* alcohol is detectable in the body is much less variable for alcohol due to the fact that it moves much more freely and predictably throughout the body than THC.[16] This means that BAC measured by various instruments are much more homogenous, whereas THC detection methods can vary widely from one another. For example, tests attempting to detect THC using blood versus urine versus saliva may result in wildly different results.

Individual characteristics, particularly frequency of use, also influence how long THC is detectable in the body to a much greater extent than alcohol. In fact, during a study in which daily marijuana smokers abstained from marijuana for 33 days, only a small minority of participants had no detectable THC after 26 days.[17] In other studies that include dosed amounts of both alcohol and THC, the THC ng/ml concentration among participants is significantly more variable than BAC, indicating that even when the amount consumed is controlled, the nature of THC makes it very difficult to accurately predict how individuals will metabolize it.[18] Complicating things even more, THC can be detected in the brain even when not detectable in the blood, meaning that intoxicating effects may remain even when it appears that THC has been eliminated from the body.[19]

Detection of THC

Due to THC's fat solubility and long half-life, it is particularly difficult to isolate recent use of marijuana from historic use. Methods of detection and what fluid is tested or from which portion of the body the fluid was drawn will also effect the ability to detect recent use. This is not the case with alcohol. While the rate of alcohol metabolization is also influenced by personal characteristics, BAC is consistent regardless of how it is detected and is eliminated much more quickly by the body.[20] This makes BAC measurement much more reliable, consistent, and predictable than detection of THC.

THC can be detected in blood, urine, and saliva, but because it is fat soluble and moves less freely throughout the body than alcohol, results from each test can vary.[21] Oral fluid tests are the most promising to detect recent use of marijuana,[22] but Oregon relies exclusively on urine and blood tests as part of its DRE evaluation. Blood and urine have the disadvantage of being much less viable for field tests, and taking blood or urine significantly increases the time needed to evaluate drivers suspected of intoxication. While a test is waiting to be administered, the driver's THC concentration also significantly declines, making it less likely that a test would detect recent use.

Several companies have developed THC "breathalyzers" that, like oral swabs, detect THC concentration as a result of recent use.[23] However, this technology is still nascent and has only recently begun clinical trials. Moreover, marijuana products that metabolize over a much longer period of time, such as edibles, or that are not consumed orally, would likely not have detectable amounts of THC in the mouth. With edibles and other non-smokable products gaining an increasing market share in other states,[24] it is unknown to what extent such devices would be able to detect consumption of edible or non-smoked marijuana products.

THC and Effects on Driving Ability

Similar to the ways in which the body processes alcohol and THC, the effects on driving differ as well. In a controlled study in laboratory conditions, alcohol increased the average speed at which a driver traveled, whereas THC on average led to a decrease in speed.[25] The same study showed that drivers attempted to compensate for their THC impairment, but alcohol-impaired drivers did not. However, THC does lead to a decrease in reaction time and also increases lane weaving while decreasing the ability to multitask (e.g. staying in lane and reacting to a pedestrian entering the street).[26] THC therefore leads to a different type of risk as compared to alcohol – less risk associated with high speed and more risk associated with impaired judgment and a lower ability to react to unexpected events.

Recent studies have also evaluated the unique risk associated with combining alcohol and THC. Beyond combining the two effects of each substance, alcohol may even increase the absorption and concentration of THC, therefore exponentially magnifying the risks associated with intoxication.[27] While drivers intoxicated with both alcohol and THC drive more slowly than drivers under the influence of alcohol alone, overall impairment is higher when the two substances are combined than if each is used separately.[28] The implications of this are two-fold. First, it demonstrates that the risks of driving under the influence is not due to speed alone and that cognitive impairment carries its own risk. Second, combinations of THC and alcohol are particularly impairing – but Oregon's current method of detection via DRE evaluation is incapable of detecting this magnified risk due to drivers with 0.08 BAC or greater not being evaluated for THC-impairment.

THC and Traffic Risk

The risk associated with THC, as with alcohol, is not monolithic. In other words, there is no singular threshold across which driving becomes "risky." Rather, various levels of concentration can increase the risk as compared to lower concentrations. This has been studied extensively in regards to alcohol, and is largely what has driven the consensus of a 0.08 BAC *per se* limit of alcohol intoxication. For example, the relative crash risk across all individuals is nearly 4 times greater for drivers with a 0.08 BAC compared to drivers with a BAC of 0, and this relative risk rises to more than 8 times greater at a BAC of 0.12.[29]

While attempts have been made to derive similar spectrums of risk for varying levels of THC concentration,[30] the research is significantly more limited than similar research regarding alcohol. This is due to several factors. First, the studies of alcohol have been over a significantly longer time horizon. Researchers have been studying the risk associated with alcohol for more than 50 years, whereas THC research is relatively new. Second, lab studies are much more difficult to conduct with THC than with alcohol due to marijuana's Schedule I status. Supply of marijuana is significantly smaller and more restricted by the federal government, and marijuana that researchers are able to use is significantly lower in THC concentration than what is on the market in Washington, Colorado, and Oregon. Third, when field studies are conducted in lieu of laboratory studies, sample sizes are smaller due to the lower use rates of marijuana compared to alcohol, leaving researchers more dependent on less reliable self-reporting of when and how much marijuana the driver consumed.

Despite the limitations on research, studies that have been conducted tend to show an elevated risk of crashes while under the influence of THC, but generally a lower overall risk as compared to alcohol impairment. The exact increase in risk of accidents or fatalities associated with THC is highly variable, and ranges between two and seven times the risk of non-intoxicated drivers.[31] Recent meta-analyses of such studies have found that THC increases the risk of driving, but that better controlled and conducted studies tend to find lower levels of risk than other studies.[32] This is likely due to the variables that are correlated with both marijuana use and riskier driving, regardless of intoxication. For example, a study by the National Highway Traffic Safety Administration found that when risk was not adjusted for factors such as age and gender, the relative odds ratio of THC intoxication and crash risk was 1.25. However, after adjustment of covariate risk factors, the odds ratio declined to 1.05.[33]

Without further research and improvements in both detection technology and study methodologies, it is virtually impossible to determine with any certainty what the relative risk of THC intoxication is and how it compares to alcohol. One primary reason for uncertainty is the potential role of false positive detection. If the THC being detected is due to non-recent use, for the purposes of the study they are in the "intoxicated" group without necessarily being intoxicated. This is similar to using a broken breathalyzer that shows someone has 0.08 BAC when they haven't had any alcohol to drink. In actuality there is no higher risk of driving because they are not under the influence, and this in turn decreases the average estimated risk of the "intoxicated" study group. Without improvements in technology to detect recent use, especially in field tests, such false positives are more likely.

Recommendations

The data and research presented above likely does not warrant a radical departure from current policy. A *per se* standard has not prevented a rise in THC-related traffic fatalities in Washington, and a number of barriers exist to its practical, objective application.[34] However, in the absence of a *per se* threshold there are five steps the state can take to mitigate the risk of THC-related intoxicated driving that does occur while working to more fully understand its risk and prevalence.

1) **Increase Public Education of Risks of Marijuana and Driving, Particularly Among Teens**
   While marijuana use among Oregon teens is less common than alcohol use, driving after marijuana use is considerably more common. The Oregon Health Authority's recently launched *Stay True to You* public education campaign focuses on lowering the propensity for teens to use marijuana. However, no public education campaign in Oregon specifically focuses on the confluence of teen use and driving. While the existing literature supports the contention that driving after marijuana use is less risky than after drinking alcohol, "less risky" is not equivalent to "safe." With driving after marijuana use among teens as high as it is, a public education campaign focused on the intoxicating effects of marijuana and the dangers of impaired driving could be a useful tool in changing such attitudes.

2) **Expand Oregon's Drug Recognition Expert program**
   Currently fewer than 200 Drug Recognition Experts are relied on to cover the entirety of the state in cases where there is suspicion of a driver under the influence of an intoxicant and who has tested negative for alcohol. Currently one of the primary reasons DREs are not called in to evaluate a driver is due to local resource constraints. Local police must wait while a DRE travels to the location and the actual exam takes time to conduct. This can lead to overtime costs for local jurisdictions as well as the opportunity cost where resources are more constrained – a police officer waiting for a DRE to arrive is not able to resume his or her normal duties. An expansion of the program could reduce wait times for DREs to be deployed and at least lower the strain on local resources.

3) **Field Test Oral Swab Detection**
   Despite the promising evidence supporting the accuracy of saliva testing through oral swabs, Oregon relies exclusively on blood and urine analysis in combination with DRE evaluations when

testing drivers. However, the limited number of DREs constrains the number of drivers that can be tested while blood and urine analysis cannot easily be conducted in the field. To increase the extent of data collection an oral swab pilot study could be developed to complement existing practices. Currently only breath and blood samples are covered under Oregon's implied consent law. However, officers in the field could ask drivers' consent to take an oral swab in the case where probable cause for THC intoxication exists under existing law. For example, Oregon State Police or local jurisdictions could use oral swabs on a limited basis where consent is given. This data could be collected in cases where DRE evaluations both do and do not occur for purposes of comparing each approach's relative cost effectiveness in detecting recent use of marijuana and intoxication.

4) More Comprehensive Data Collection

A major hurdle to policy-making on the subject of THC-intoxicated driving is an absence of data. While comprehensive data exists for all states in the cases of fatal accidents due to federal requirements, a large portion of DUII incidents do not result in such collisions. Data for both crashes and simple traffic stops is sparse, disparate, and incomplete. For example, data involving DRE evaluations by Oregon State Police (OSP) resides in one central place with OSP, but data that does not involve an OSP officer or a DRE evaluation resides at the local jurisdiction conducting the stop. Moreover, even in fatal accidents, drivers in Oregon are tested for marijuana at a significantly lower rate than in other legalization states, making it difficult to compare the incidence of THC-intoxication across states.

The nature of data collection in Oregon also makes it virtually impossible to understand the degree to which alcohol and marijuana are used in conjunction by drivers. A driver is not evaluated for any other substance if they have a BAC of 0.08 or greater. As discussed above, the interaction of alcohol and marijuana is uniquely problematic, but Oregon lacks any real detail on the scope of this problem.

To increase the comprehensiveness and usefulness of such data in Oregon, the collection and sharing of data could be expanded in three ways:

- Test drivers for THC intoxication where probable cause exists even when the driver's BAC exceeds 0.08. This test could be conducted either with the existing DRE evaluation or a pilot study of oral swabs (see above).
- Test more drivers involved in fatal accidents for controlled substances. Currently, ORS 146.113 only requires drug tests in such cases at the discretion of the medical examiner, whereas tests for alcohol are required. To Increase the rate of drug testing of such drivers, a revision of this statute could be considered.
- Create a centralized data repository of data already being collected by all jurisdictions throughout the state for all DUII-related traffic stops and accidents. Such a database could harmonize disparate data sets and enable regular reporting, thus enabling decision-makers to more regularly and more fully understand the nature of the issue.

5) **Further Research into Detection Technology and Crash Risk**

Federal limitations on research into cannabis due to its Schedule I status make it exceedingly difficult to thoroughly investigate questions of public health. The nature of the way in which cannabis is metabolized by the body and the differences with the body's processing of alcohol also make reliable field detection more difficult. Both are reasons why instituting a *per se* limit on THC intoxication may be premature.

For a *per se* standard for THC to be established equivalent to the 0.08 BAC standard, two specific areas of research likely need to be more fully developed. First, standardized field detection tools could be strengthened to detect *recent use* and *impairment*, separate from levels of THC that may be due to chronic but non-recent marijuana use. Second, research could be conducted to isolate the dose-response relationship of THC and impairment. Specifically, questions such as amounts of THC and its effect on concentration in the body and impairment levels and how such effects differ by product type (e.g. smokable versus edible marijuana products) are critical to establishing a *per se* standard.

The State of Oregon has already recognized the need for sponsoring further cannabis research at the state level and taken steps to accomplish this goal. The SB 844 Task Force in February 2016 recommended the creation of a cannabis research institute focusing on, among other topics, issues of public health.[35] The passage of HB 3400 during the 2015 Legislative Session also established research certificates as a recreational license type. Creating the recommended research institute and licensing research certificates with stated goals of investigating the public health implications of cannabis generally, and the area of THC-related DUII and its intoxicating effects specifically, would be a significant step towards informing future policies.

Conclusion

Due to restrictions on cannabis research and limited data, it is difficult to make definitive statements about the risk of THC-intoxicated driving. The body of evidence that does exist indicates that while attitudes towards driving after marijuana use are considerably more relaxed than in the case of alcohol, the risk of crashes while driving under the influence of THC is lower than drunk driving. Little evidence exists to compel a significant change in status quo policy or institute a *per se* intoxication standard for THC. Instead, recommendations in this report aim to find avenues to change attitudes towards THC and driving among youth, increase the quality and availability of data, and strengthen the body of research.

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