# CANNABIS & DRIVING

International Council on Alcohol, Drugs & Traffic Safety

# 2: Recent Experimental Evidence

## How is driving performance measured?

Driving is a complex and demanding task that involves a wide range of cognitive, perceptual, and motor functions. The most common measure of driving performance is the standard deviation of lateral position (SDLP), a measure of lane weaving, swerving, and overcorrecting. It is very sensitive to alcohol and drug effects. The change in SDLP associated with a blood alcohol concentration (BAC) of .05 is widely used as the benchmark for *clinically relevant* driving impairment[1] as this is the legal driving limit in many jurisdictions. Other common measures include reaction time, speed, and headway (the distance a driver leaves between their vehicle and the vehicle ahead).

Since individuals have a different baseline level of driving performance, experimental studies generally examine how driving performance changes under different conditions. Researchers do this by comparing a driver's *normal* level of performance (e.g., after receiving a placebo or before being given alcohol or cannabis) to their performance after being given a particular dose of alcohol or cannabis or being deprived of sleep.

The most realistic way to assess driving performance is by conducting an *on-road* study in which participants drive while supervised under real-world conditions. However, these designs are not often used because of the ethical and logistical challenges that they entail. Driving simulators are commonly used instead. In addition to their practicality, a key advantage of using a driving simulator is that investigators can control every aspect of the driving environment, including weather and road conditions, vehicle dynamics, and other vehicle behaviours.[2] This makes it possible to simulate scenarios and conditions that would be impossible to control, and thereby ethically test, in the real world.

## How much does cannabis impair driving?

### *Cannabis impairs driving, although the degree of impairment it produces varies substantially depending on the dose and the individual.*

A series of on-road studies conducted in the Netherlands in 2000 established that smoked cannabis (100 and 200 µg/kg THC) significantly increases a driver's SDLP.[3] This finding has been confirmed by most studies since, including a study which used the highly advanced driving simulator at the University of Iowa.[4] In a very recent on-road study[5], participants vaporized several types of cannabis that contained different ratios of tetrahydrocannabinol (THC) to cannabidiol (CBD). Regardless of the

CBD content, cannabis containing THC produced driving impairment at 40 min that was similar in magnitude to that typical of drivers with a BAC of .05. At 4 hours, it was closer in magnitude to what is typical among drivers with a BAC of .02. By contrast, CBD, when taken alone, did not produce any driving or cognitive impairment.

In another on-road study investigating driving performance in occasional and chronic frequent cannabis consumers, only occasional consumers were substantially impaired.[6] Among chronic frequent consumers, neither 10 nor 20 mg THC produced *clinically relevant* driving impairment. This does not mean THC is harmless for chronic frequent consumers; rather, it indicates that people who use cannabis regularly develop a tolerance to some of its impairing effects. Chronic consumers may also consume higher doses of THC to overcome their tolerance and achieve a high. When they do their driving may then also be impaired.[7]

Some studies have shown cannabis increases headway, meaning drivers leave a larger gap between them and the vehicle ahead.[8] This, like slower driving speeds, is thought to be a compensatory mechanism drivers use when they think their driving might be impaired. Reaction times while driving were slowed in one simulator study[9] but unaffected in a separate on-road study.[10] In this latter study, a low dose of THC (100 µg/kg) did not impair city driving performance; highway driving performance was also relatively unaffected but worsened considerably with higher doses, especially when combined with alcohol.

In order to make sense of discrepant findings, Simmons and colleagues (2022) conducted a rigorous systematic review and meta-analysis.[11] They found that although cannabis led to slower driving speeds, it nonetheless negatively affected lateral control of the vehicle, such that drivers under the influence of cannabis tended to weave more within their lane. However, there was insufficient evidence that "cannabis reliably changes rates of crashes, hazard reaction time (RT), headway, variability, time out of lane, speed variability, speed exceedances or time speeding." Overall, this meta-analysis indicates cannabis does impair driving, even despite slowed driving speeds, but more research is required to fully characterize how cannabis affects driving.

## How long after using cannabis are drivers safe to drive?

Unfortunately, there is no definite period of time after which it is safe to drive after using cannabis. Cannabis affects different people in different ways, and the time needed to recover from cannabis intoxication varies. Generally speaking, for a given THC dose, someone who uses cannabis more frequently and has a greater tolerance for THC can safely drive sooner than someone who uses cannabis occasionally. However, this *tolerance effect* may be negated if the person with a higher tolerance uses a higher THC dose to achieve a similar effect to someone with a lower tolerance who uses a lower THC dose.

The length of time needed to recover from cannabis intoxication is not fixed and depends on various factors, such as biological characteristics of consumers, type of cannabis consumed, dose, and method of ingestion.

In a recent on-road driving study involving occasional cannabis consumers, participants who vaporized 13.75 mg THC were, on average, safe to drive by 4-5 hours.[5] This was confirmed by a recent review which showed impairment typically passes within ~5 hours of inhaling 20 mg THC and ~8 h after ingesting 20 mg THC.[12] Importantly, impairment recovery times may be shorter or longer depending on the THC dose, the experience of consumers, and how how they consume it. When cannabis is ingested, impairment lasts longer and it takes longer to recover because of the way THC is absorbed and metabolized compared with when it is inhaled.

## If a driver tests positive for THC, does that mean they are impaired?

*No; it depends on the dose, the route of administration, and the frequency of use among individuals, as well as whether cannabis has been consumed alone or in combination with alcohol or other substances.*

There is a weak, negative correlation between THC concentration and driving performance (i.e., individuals with higher THC concentrations in their system exhibit poorer driving performance).[8] However, at the individual level, it is impossible to reliably

infer level of impairment from THC concentrations alone. Peak THC concentrations occur while smoking or vaporizing and decrease rapidly after inhalation ceases.[13] Intoxication, on the other hand, is typically greatest between 30 min and 1h after smoking. This means that individuals experience the strongest impairing effects of cannabis after THC concentrations have already peaked and begun to decline.

THC may be detectable in blood at low concentrations in chronic frequent cannabis consumers long after acute impairment has subsided. In fact, THC can remain at detectable concentrations for weeks, especially among chronic consumers.[14] When cannabis is consumed orally (e.g., edibles), intoxication typically peaks around 2 hours and may last for up to 6 or more hours.[15] Even with much higher doses, THC concentrations after ingestion are an order of magnitude lower than when cannabis is smoked or vaporized because of differences in the way THC is absorbed in the body. These issues are discussed in more detail in ICADTS Cannabis-Impaired Driving Detection & Toxicology.

## How does cannabis compare with alcohol?

There are similarities in the effects of alcohol and cannabis on driving, such as increased SDLP (i.e., greater lane weaving), but the two drugs produce distinct behavioural effects.[16] Unlike cannabis, alcohol tends to decrease inhibition, inflate self-confidence, and increase risk-taking behaviour, such as speeding and risky driving manoeuvres. While cannabis does impair several important driving-related skills, it is often associated with slower driving, increased headway, and a reduced willingness to drive.[5,8] These results suggest cannabis consumers have a heightened awareness of their impairment and engage in potential compensatory mechanisms but results do not preclude cannabis use impairing driving performance.

In comparing the effects of cannabis to those of alcohol on driving performance and behaviour, Simmons and colleagues (2022) also observed the effect of cannabis was deemed similar to low levels of alcohol (e.g., a BAC up to .05).[11]

Alcohol and cannabis produce different patterns of impairing effects.

*The combined effect of alcohol, even in low concentrations, and cannabis is particularly dangerous for driving.*

The effect of combining alcohol and cannabis is additive, producing greater impairment than that caused by either drug alone.[11] In one on-road study, low (100 µg/kg) and moderate (200 µg/kg) THC doses combined with a .04 BAC produced road-tracking impairment similar to BACs of .09 and .14, respectively.[10]

## What are the limitations of experimental studies of cannabis and driving?

All study methods have strengths and limitations. A notable advantage of experimental studies is the ability to measure the effects of cannabis on driving performance and behaviour while an individual is actually under its influence. As discussed in this fact sheet, testing positive for THC does not necessarily mean an individual is impaired by cannabis while driving, which creates a notable limitation for epidemiological studies which aim to quantify the crash risk associated with cannabis. However, experimental studies do have important limitations. A systematic review and meta-analysis[11] noted findings from experimental studies may not generalize well to the entirety of the cannabis-using population of drivers. Specifically, experimental studies have historically excluded older drivers, teen or novice drivers, medical cannabis consumers, individuals who are using cannabis for the first time, and heavier cannabis consumers with higher THC tolerances. Additionally, participants are often self-referred (rather than randomly selected) and became unblinded to their status as individuals in either the active cannabis group or the control group. This can lead to biased outcomes.

## What research is still needed?

Research is needed to address several remaining questions. Most experimental studies involve standard doses of THC administered through smoking or vaporization with the goal of achieving measurable and substantial impairment in an individual. Much less is known about the effects of cannabis on driving in patients using medical cannabis in the real world and using individually tailored doses of THC or CBD. Further research is also needed to better understand how different doses of cannabis affect driving in new, occasional, and chronic or frequent consumers.

Finally, cannabis is often taken in combination with other substances. There is a body of research examining the combined effects of THC and alcohol but much less is known about the effects of using THC and CBD with other commonly prescribed medications such as opioids, sedating antidepressants, Z-drugs, and benzodiazepines.

More research is needed to understand how medical cannabis affects driving.

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The International Council on Alcohol, Drugs & Traffic Safety (ICADTS) is an independent not-for-profit body whose only goal is to reduce mortality and morbidity brought about by misuse of alcohol and drugs by operators of vehicles in all modes of transport.

To accomplish this goal, the Council sponsors international and regional conferences to collect, disseminate and share essential information among professionals in the fields of law, medicine, public health, economics, law enforcement, public information and education, human factors and public policy.

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