CANNABIS & DRIVING

International Council on Alcohol, Drugs & Traffic Safety

4: Cannabis-Impaired Driving Detection & Toxicology

Are THC concentrations in blood predictive of driver impairment?

At the population level, the higher the Δ^9-tetrahydrocannabinol (THC) concentrations in blood, the greater the fraction of cannabis consumers who show impairment.[1] This association is clearest in occasional cannabis consumers and may differ in chronic frequent cannabis consumers who develop partial tolerance to the effects of THC. However, at the individual level, it is difficult to predict impairment in individual drivers.

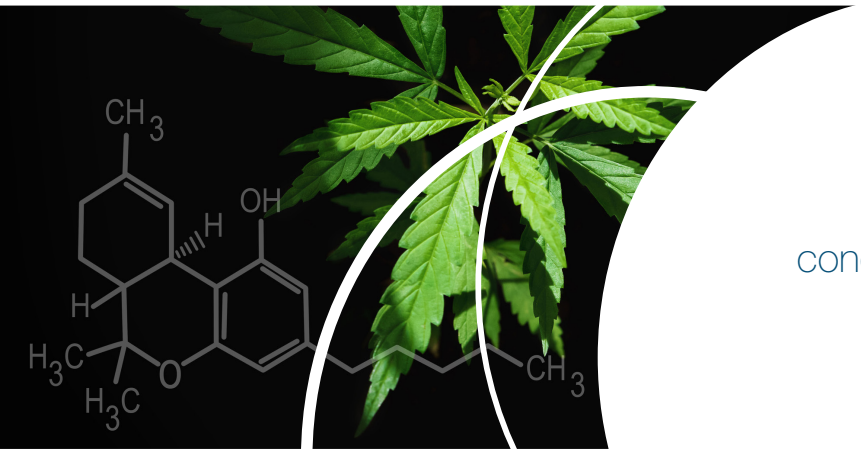
At the population level, the fraction of cannabis consumers who show any degree of impairment increases with higher tetrahydrocannabinol (THC) concentrations in blood.[1]

At the individual level, the association between THC concentration and driving performance is difficult to measure.[1,2] A dissociation between blood THC concentrations and impact on psychomotor function and cognition exists for several reasons. These include:

1. Peripheral blood THC concentrations do not represent THC in the brain.[3]
2. Individuals may develop partial tolerance after repeated exposure to the impairing effects of THC.[4,5]
3. After chronic daily cannabis intake, THC (above 1 ng/mL) can be detected in the blood of some consumers for many days, sometimes in the absence of impairment.[6]
4. In road traffic practice, THC concentrations are usually detected in blood up to 1-8 h after a traffic crash or stop. These do not represent THC concentrations at the time of the crash (i.e., blood THC concentrations decrease approximately 74% in the first 30 min and by 90% in the first 1.4 h).[7]
5. THC concentrations widely vary after the intake of different THC formulations while producing similar levels of impairment (e.g., THC peak concentrations are low after oral formulation intake and initially high after vaping or smoking).[8]

Are THC concentrations in oral fluid predictive of driver impairment?

Positive oral fluid test results may indicate recent cannabis use because test sensitivity is usually limited to a few hours after smoking (the time depending upon the detection threshold of the device).[9] THC in oral fluid primarily represents coating of the mouth after inhalation of drug-laden smoke or vapour. It is not associated with THC concentrations in blood or driver performance.[2] Two to four hours after cannabis intake, coating of the oral fluid dissipates and oral fluid THC concentrations approximately parallel blood THC concentrations, but not at the same levels.[10] We cannot accurately predict blood concentrations of THC from oral fluid concentrations because of high intra-subject and inter-subject variability.[11]



We cannot accurately predict blood concentrations of THC from oral fluid concentrations because of high intra-subject and inter-subject variability.

Is there a specific (per se) THC limit that allows differentiation of impaired and non-impaired drivers?

No; while impairment from THC increases at the *population* level, THC concentrations do not predict impairment at the *individual* level.

Can behavioural standardized field sobriety tests (SFSTs) alone reliably detect THC-induced driver impairment?

Current standardized field sobriety tests include horizontal gaze nystagmus (HGN), one leg stand (OLS) and walk and turn (WAT). They were developed to identify alcohol-impaired driving and do not adequately detect THC-induced driver impairment.

THC does not produce HGN.[12,13] However, of these three behavioural tests, the OLS is the most sensitive at detecting THC effects.[12,13] The Drug Evaluation and Classification Program (DECP) was later developed to improve the detection of impaired driving following the use of seven classes of drugs drug in addition to alcohol.[14] The DECP captures physiological measures, pupil size/light reaction, and performance on psychophysical tests including the OLS, WAT, Finger to Nose (FTN), and Modified Romberg Balance (MRB). These are assessed in a highly standardized exam conducted by specially trained police officers. Cannabis significantly increased pulse, systolic blood pressure, and pupil size, with documented errors on the FTN and WAT, eyelid tremors on the MRB, sway on the OLS, and pupil rebound dilation.[15] THC impairment was identified in ≥ 96.7% of THC-impaired driving cases if two of these four test criteria were met, ≥3 FTN misses, MRB eyelid tremors, ≥2 OLS clues, and/or ≥2 WAT clues. False negative rates of the DECP are unknown because these procedures are only applied by police to drivers who are suspected of drug-impaired driving.[15]

Many jurisdictions are developing other behavioural tests to detect THC-induced impairment. The major challenge is in distinguishing THC-related impairment from an individual's driving performance when not drug-affected. Such reference data can be collected in laboratory settings but cannot be collected at the roadside. Without such normative data, standards of cannabis impairment are difficult to define for behavioural tests performed on drivers suspected of drug-impaired driving at the roadside.

Are urine drug concentrations alone appropriate to assess impairment in drivers suspected of driving under the influence of cannabis?

No, urine concentrations of cannabis metabolites simply identify past cannabis exposure and in no way identify THC impairment. Urine drug/metabolite concentrations should not be used to interpret the effect of a drug or a chemical on human behaviour.[16]

References

1. Ramaekers, J. G., Mason, N. L., Kloft, L., & Theunissen, E. L. (2021). The why behind the high: determinants of neurocognition during acute cannabis exposure. *Nature Reviews Neuroscience*, *22(7)*, 439-454.
2. McCartney, D., Arkell, T. R., Irwin, C., Kevin, R. C., & McGregor, I. S. (2021). Are blood and oral fluid .9-tetrahydrocannabinol (THC) and metabolite concentrations related to impairment? A meta-regression analysis. *Neuroscience & Biobehavioral Reviews*, *134*, 104433.
3. Huestis, M. A. (2007). Human cannabinoid pharmacokinetics. *Chemistry & Biodiversity*, *4(8)*, 1770-1804.
4. Newmeyer, M. N., Swortwood, M. J., Abulseoud, O. A., & Huestis, M. A. (2017). Subjective and physiological effects, and expired carbon monoxide concentrations in frequent and occasional cannabis smokers following smoked, vaporized, and oral cannabis administration. *Drug and Alcohol Dependence*, *175*, 67-76.
5. Ramaekers, J. G., Mason, N. L., & Theunissen, E. L. (2020). Blunted highs: pharmacodynamic and behavioral models of cannabis tolerance. *European Neuropsychopharmacology*, *36*, 191-205.
6. Bergamaschi, M. M., Karschner, E. L., Goodwin, R. S., Scheidweiler, K. B., Hirvonen, J., Queiroz, R. H., & Huestis, M. A. (2013). Impact of prolonged cannabinoid excretion in chronic daily cannabis smokers' blood on per se drugged driving laws. *Clinical Chemistry*, *59(3)*, 519-526..
7. Hartman, R. L., Brown, T. L., Milavetz, G., Spurgin, A., Gorelick, D. A., Gaffney, G. R., & Huestis, M. A. (2016). Effect of blood collection time on measured Δ9-tetrahydrocannabinol concentrations: implications for driving interpretation and drug policy. *Clinical Chemistry*, *62(2)*, 367-377.
8. McCartney, D., Arkell, T. R., Irwin, C., & McGregor, I. S. (2021). Determining the magnitude and duration of acute Δ9-tetrahydrocannabinol (Δ9-THC)-induced driving and cognitive impairment: a systematic and meta-analytic review. *Neuroscience & Biobehavioral Reviews*, *126*, 175-193.
9. Swortwood, M. J., Newmeyer, M. N., Andersson, M., Abulseoud, O. A., Scheidweiler, K. B., & Huestis, M. A. (2017). Cannabinoid disposition in oral fluid after controlled smoked, vaporized, and oral cannabis administration. *Drug Testing and Analysis*, *9(6)*, 905-915..
10. Desrosiers, N. A., & Huestis, M. A. (2019). Oral fluid drug testing: analytical approaches, issues and interpretation of results. *Journal of Analytical Toxicology*, *43(6)*, 415-443.
11. Busardo, F. P, Pichini, S., Pellegrini, M., Montana, A., Fabrizio Lo Faro, A., Zaami, S., & Graziano, S. (2018). Correlation between blood and oral fluid psychoactive drug concentrations and cognitive impairment in driving under the influence of drugs. *Current Neuropharmacology*, *16(1)*, 84-96.
12. Bosker, W. M., Kuypers, K. P., Theunissen, E. L., Surinx, A., Blankespoor, R. J., Skopp, G., ... & Ramaekers, J. G. (2012). Medicinal Δ9 tetrahydrocannabinol (dronabinol) impairs on the road driving performance of occasional and heavy cannabis users but is not detected in Standard Field Sobriety Tests. *Addiction*, *107(10)*, 1837-1844.
13. Downey, L. A., King, R., Papafotiou, K., Swann, P., Ogden, E., Boorman, M., & Stough, C. (2012). Detecting impairment associated with cannabis with and without alcohol on the Standardized Field Sobriety Tests. *Psychopharmacology*, *224(4)*, 581-589.
14. Hartman, R. L., Richman, J. E., Hayes, C. E., & Huestis, M. A. (2016). Drug Recognition Expert (DRE) examination characteristics of cannabis impairment. *Accident Analysis & Prevention*, *92*, 219-229.
15. Porath-Waller, A. J., & Beirness, D. J. (2014). An examination of the validity of the standardized field sobriety test in detecting drug impairment using data from the drug evaluation and classification program. *Traffic Injury Prevention*, *15(2)*, 125-131.
16. Elliott, S. P., Stephen, D. W., & Paterson, S. (2018). The United Kingdom and Ireland association of forensic toxicologists forensic toxicology laboratory guidelines (2018). *Science & Justice*, *58(5)*, 335-345.

About ICADTS

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.

Acknowledgements

Special thanks to ICADTS Drugged Driving Work Group Co-Chairs: Jan Ramaekers, Maastricht University (Netherlands) Robyn D. Robertson, Traffic Injury Research Foundation (Canada) & Thomas Arkell, Swinburne University (Australia) and the Members who contributed their expertise.

Australia
Jeremy Davey | University of the Sunshine Coast
Iain McGregor | University of Sydney
Luke Downey | Swinburne University
Wayne Hall | University of Queensland

Belgium
Alain Verstraete | Ghent University

Canada
Christine Wickens | Centre for Addiction and Mental Health, Canada
Jeff Brubacher | University of British Columbia
Sarah Simmons | Traffic Injury Research Foundation

Germany
Anja Knoche | Federal Highway Research Institute (BASt)

Ireland
Denis Cusack | Medical Bureau of Road Safety, University College Dublin & Senior Coroner

Netherlands
Eef Theunissen | Maastricht University

Norway
Hallvard Gjerde | Oslo University Hospital
Vigdis Vindenes | Oslo University Hospital

Portugal
Brendan Hughes | European Monitoring Centre for Drugs and Drug Addiction

Spain
F. Javier Alvarez | University of Valladolid

Switzerland
Marc Augsburger | University of Lausanne

USA
Christine Moore | 9-Delta Analytical LLC
Marilyn Huestis | Huestis & Smith Toxicology, LLC
Randy Atkins | National Highway Traffic Safety Administration
Tara Kelley-Baker | National Highway Traffic Safety Administration
Richard P. Compton | Traffic Safety Research LLC
Ryan Smith | National Transportation Safety Board
Staci Hoff | Washington Traffic Safety Commission
Eduardo Romano | Pacific Institute for Research & Evaluation

THE INTERNATIONAL COUNCIL ON ALCOHOL, DRUGS & TRAFFIC SAFETY
ICADTS

For more information visit
www.icadtsinternational.com
Email: admin@icadtsinternational.com