**SOFT/AAFS Drugs and Driving Committee Literature (Based on ASB Standard 120)**

**Cannabinoids (Completed Re-Review in 2021)**

* Arkell, T.R. et al. [Cannabidiol (CBD) content in vaporized cannabis does not prevent tetrahydrocannabinol (THC)-induced impairment of driving and cognition.](https://www.ncbi.nlm.nih.gov/pubmed/31044290) *Psychopharmacology (Berl)* 236:2713-2724 (2019)
* Bidwell, L.C. et al. [Association of naturalistic administration of cannabis flower and concentrates with intoxication and impairment.](https://pubmed.ncbi.nlm.nih.gov/32520316) *JAMA Psychiatry* 77:787-796 (2020)
* Bondallaz, P. et al. [Cannabis and its effects on driving skills.](https://www.ncbi.nlm.nih.gov/pubmed/27701009) *Forensic Sci Int* 268:92-102 (2016)
* Dubois, S. et al. [The combined effects of alcohol and cannabis on driving: Impact on crash risk.](https://www.ncbi.nlm.nih.gov/pubmed/25612879) *Forensic Sci Int* 248:94-100 (2015)
* Hartley, S. et al. [Effect of smoked cannabis on vigilance and accident risk using simulated driving in occasional and chronic users and the pharmacokinetic-pharmacodynamic relationship.](https://pubmed.ncbi.nlm.nih.gov/30872375) *Clin Chem* 65:684-693 (2019)
* Hartman, R.L. et al. [Cannabis effects on driving skills.](http://www.ncbi.nlm.nih.gov/pubmed/23220273) *Clin Chem* 59:478-492 (2013)
* Hartman, R.L. et al. [Cannabis effects on driving lateral control with and without alcohol.](https://www.ncbi.nlm.nih.gov/pubmed/26144593) *Drug Alcohol Depend* 154:25-37 (2015)
* Hartman, R.L. et al. [Cannabis effects on driving longitudinal control with and without alcohol.](https://www.ncbi.nlm.nih.gov/pubmed/26889769) *J Appl Toxicol* 36:1418-1429 (2016)
* Hartman, R.L. et al. [Effect of blood collection time on measured Δ9-tetrahydrocannabinol concentrations: implications for driving interpretation and drug policy.](https://www.ncbi.nlm.nih.gov/pubmed/26823611) *Clin Chem* 62:367-377 (2016)
* **[NEW]** Høiseth, G. [Impairment due to alcohol, tetrahydrocannabinol, and benzodiazepines in impaired drivers compared to experimental studies.](https://pubmed.ncbi.nlm.nih.gov/27327554/) *Traffic Inj Prev* 18:244-250 (2019)
* Huestis, M.A. et al. [Blood cannabinoids. I. Absorption of THC and formation of 11-OH-THC and THCCOOH during and after smoking marijuana.](http://www.ncbi.nlm.nih.gov/pubmed/1338215) *J Anal Toxicol* 16: 276-282 (1992)
* Huestis, MA. [Cannabis (Marijuana) – Effects on Human Behavior and Performance.](https://pubmed.ncbi.nlm.nih.gov/26256486/) Forensic Sci Rev 14:15-60 (2002)
* Martin, J.L. et al. [Cannabis, alcohol and fatal road accidents.](https://www.ncbi.nlm.nih.gov/pubmed/29117206) *PLoS One* 12:e0187320 (2017)
* National Safety Council-Committee on Alcohol and Other Drugs. [Position on the use of cannabis (marijuana) and driving.](http://www.ncbi.nlm.nih.gov/pubmed/23325786) *J Anal Toxicol* 37:47-49 (2013)
* Neavyn, M.J. et al. [Medical marijuana and driving: a review.](https://www.ncbi.nlm.nih.gov/pubmed/24648180) *J Med Toxicol* 10:269-279 (2014)
* Newmeyer, M.N. et al. [Evaluation of divided attention psychophysical task performance and effects on pupil sizes following smoked, vaporized and oral cannabis administration.](https://www.ncbi.nlm.nih.gov/pubmed/28138971) *J Appl Toxicol* 37:992-932 (2017)
* Ramaekers, J.G. et al. [Marijuana, alcohol and actual driving performance.](http://www.ncbi.nlm.nih.gov/pubmed/12404625) *Hum Psychopharmacol* 15:551-558 (2000)
* Ramaekers, J.G. et al. [High-potency marijuana impairs executive function and inhibitory motor control.](http://www.ncbi.nlm.nih.gov/pubmed/?term=High-Potency+Marijuana+Impairs+Executive+Function+and+Inhibitory+Motor+Control.) *Neuropsychopharmacology* 31:2296-2303 (2006)

**CNS Stimulants (Completed Re-Review in 2022)**

* Amphetamine/Methamphetamine
	+ **[NEW]** Downey, L.A. et al. [Examining the effect of dl-3,4-methylenedioxymethamphetamine (MDMA) and methamphetamine on the Standardized Field Sobriety Tests.](https://pubmed.ncbi.nlm.nih.gov/22459201/) *Forensic Sci Int* 220:e33-36 (2012)
	+ Jones, A.W. et al. [Driving under the influence of central stimulant amines: age and gender differences in concentrations of amphetamine, methamphetamine, and ecstasy in blood.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Driving+under+the+influence+of+central+stimulant+amines%3A+age+and+gender+differences+in+concentrations+of+amphetamine%2C+methamphetamine%2C+and+ecstasy+in+blood.)J Stud Alcohol Drugs 69:202-208 (2008)
	+ **[NEW]** Høiseth, G. [Impairment due to amphetamines and benzodiazepines, alone and in combination.](https://pubmed.ncbi.nlm.nih.gov/25456327/) *Drug Alcohol Depend* 145:174-9 (2014)
	+ Logan, B.K. et al. [Methamphetamine and driving impairment.](http://www.ncbi.nlm.nih.gov/pubmed/8656187)J Forensic Sci 41:457-464 (1996)
	+ Logan, B.K. et al. [Amphetamines: an update on forensic issues.](https://pubmed.ncbi.nlm.nih.gov/11499897/) J Anal Toxicol 25:400-404 (2001)
	+ **[NEW]** Musshoff, F. and Madea, B. [Driving under the influence of amphetamine-like drugs.](https://pubmed.ncbi.nlm.nih.gov/22335607/) *J Forensic Sci* 57:413-419 (2012)
* MDMA
	+ **[NEW]** Bosker, W.M. et al. [MDMA (ecstasy) effects on actual driving performance before and after sleep deprivation, as a function of dose and concentration in blood and oral fluid.](https://pubmed.ncbi.nlm.nih.gov/21952668/) Psychopharmacology (Berl) 222:367-376 (2012)
	+ **[NEW]** Downey, L.A. et al. [Examining the effect of dl-3,4-methylenedioxymethamphetamine (MDMA) and methamphetamine on the Standardized Field Sobriety Tests.](https://pubmed.ncbi.nlm.nih.gov/22459201/) *Forensic Sci Int* 220: e33-36 (2012)
	+ Kuypers, K.P. et al. [MDMA and alcohol effects, combined and alone, on objective and subjective measures of actual driving performance and psychomotor function.](http://www.ncbi.nlm.nih.gov/pubmed/?term=MDMA+and+alcohol+effects%2C+combined+and+alone%2C+on+objective+and+subjective+measures+of+actual+driving+performance+and+psychomotor+function.)Psychopharmacology (Berl) 187:467-475 (2006)
	+ Kuypers, K.P. et al. [Acute effects of nocturnal doses of MDMA on measures of impulsivity and psychomotor performance throughout the night.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Acute+effects+of+nocturnal+doses+of+MDMA+on+measures+of+impulsivity+and+psychomotor+performance+throughout+the+night.)Psychopharmacology (Berl) 192:111-119 (2007)
	+ Lamers, C.T. et al. [Dissociable effects of a single dose of ecstasy (MDMA) on psychomotor skills and attentional performance.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Dissociable+effects+of+a+single+dose+of+ecstasy+(MDMA)+on+psychomotor+skills+and+attentional+performance.)J Psychopharmacol 17:379-387 (2003)
	+ Logan, B.K. and Couper, F.J. [3,4-Methylenedioxymethamphetamine (MDMA, ecstasy) and driving impairment.](http://www.ncbi.nlm.nih.gov/pubmed/11714155)J Forensic Sci 46:1426 (2001)
	+ **[NEW]** Musshoff, F. and Madea, B. [Driving under the influence of amphetamine-like drugs.](https://pubmed.ncbi.nlm.nih.gov/22335607/) *J Forensic Sci* 57: 413-419 (2012)
	+ **[NEW]** Veldstra, J.L. et al. [Effects of alcohol and ecstasy (MDMA 100 mg) on simulated driving performance and traffic safety.](https://pubmed.ncbi.nlm.nih.gov/22076245/) Psychopharmacology (Berl) 222:377-390 (2012)
* Cocaine
	+ **[NEW]** Ellefsen K.N. et al. [Pharmacodynamic effects and relationships to plasma & oral fluid pharmacokinetics after intravenous cocaine administration.](https://pubmed.ncbi.nlm.nih.gov/27114201/) *Drug Alcohol Depend* 163:116-125 (2016)
	+ **[NEW]** Huertas T. et al. [Stability of Cocaine Compounds in Biological Fluids During Post-Analytical Sample Storage.](https://pubmed.ncbi.nlm.nih.gov/33313886/) *J Anal Toxicol* 44:864-870 (2020)
	+ Isenschmid, D.S. [Cocaine: Effects on Human Performance and Behavior.](https://pubmed.ncbi.nlm.nih.gov/26256487/) Forensic Sci Rev 14:61-100 (2002)
	+ **[NEW]** Jenkins A. J. et al. [Correlation between pharmacological effects and plasma cocaine concentrations after smoked administration.](https://pubmed.ncbi.nlm.nih.gov/12422990/) J Anal Toxicol 26:382-392 (2002)
	+ Jones, A.W. et al. [Concentrations of cocaine and its major metabolite benzoylecgonine in blood samples from apprehended drivers in Sweden.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Concentrations+of+cocaine+and+its+major+metabolite+benzoylecgonine+in+blood+samples+from+apprehended+drivers+in+Sweden.) Forensic Sci Int 177:133-139 (2008)
	+ Jones, A.W. [Forensic Drug Profile: Cocaethylene.](https://pubmed.ncbi.nlm.nih.gov/30796807) J Anal Toxicol 43:155-160 (2019)

**CNS Depressants (Completed Re-Review in 2024)**

* Carisoprodol/Meprobamate
	+ Bramness, J.G. et al. [Impairment due to intake of carisoprodol.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Impairment+due+to+intake+of+carisoprodol.) *Drug Alcohol Depend* 74:311-318 (2004)
	+ **[NEW]** Bramness, J.G. et al. [The risk of traffic accidents after prescription carisoprodol](https://pubmed.ncbi.nlm.nih.gov/17854578/) *Accid Anal Prev* 39:1050-1055 (2007)
	+ Logan, B.K, et al. [Carisoprodol, meprobamate and driving impairment.](http://www.ncbi.nlm.nih.gov/pubmed/10855968) *J Forensic Sci* 45:619-623 (2000)
	+ Robertson, M.D. and Marinetti, L.J. [Carisoprodol – Effects on human performance and behavior.](https://www.soft-tox.org/assets/docs/soma-carisoprodol.pdf) *Forensic Sci Rev*15:1-10 (2003)
	+ Zacny, J.P. et al. [Characterizing the subjective and psychomotor effects of carisoprodol in healthy volunteers.](https://www.ncbi.nlm.nih.gov/pubmed/21884720) *Pharmacol Biochem Behav* 100:138-143 (2011)
	+ Zacny, J.P. et al. [Subjective and psychomotor effects of carisoprodol in combination with oxycodone in healthy volunteers.](https://www.ncbi.nlm.nih.gov/pubmed/21840651) *Drug Alcohol Depend* 120:229-232 (2012)
* Zolpidem
	+ Hindmarch, I. et al. [Residual effects of zaleplon and zolpidem following middle of the night administration five hours to one hour before awakening.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Residual+effects+of+zaleplon+and+zolpidem+following+middle+of+the+night+administration+five+hours+to+one+hour+before+awakening.) *Hum Psychopharmacol* 16:159-167 (2001)
	+ Logan, B.K. and Couper, F.J. [Zolpidem and driving impairment.](http://www.ncbi.nlm.nih.gov/pubmed/11210892) *J Forensic Sci* 46:105-10 (2001)
	+ **[NEW]** Rohrig, T.P. and Moore C.M. [Zolpidem: Forensic aspects for the toxicologist and pathologist.](https://pubmed.ncbi.nlm.nih.gov/25869945/) *Forensic Sci Med Pathol* 1: 81-90 (2005)
	+ **[NEW]** Vermeeren, A. et al. [Residual effects of low-dose sublingual zolpidem on highway driving performance the morning after middle-of-the-night use.](https://pubmed.ncbi.nlm.nih.gov/24587571/) *Sleep* 37:489-96 (2014)
	+ **[NEW]** Verster, J.C. et al. [Middle-of-the-night administration of sleep medication: a critical review of the effects on next morning driving ability.](https://pubmed.ncbi.nlm.nih.gov/24909576/) *Curr Drug Saf* 9:205-11 (2014)
	+ Verster, J. C. et al. [Residual effects of middle-of-the-night administration of zaleplon and zolpidem on driving ability, memory functions, and psychomotor performance.](http://www.ncbi.nlm.nih.gov/pubmed/12454557) *J Clin Psychopharmacol* 22:576-583 (2002)
	+ Verster, J.C. et al. [Zolpidem and traffic safety - the importance of treatment compliance.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Zolpidem+and+traffic+safety+-+the+importance+of+treatment+compliance.) *Curr Drug Saf* 2:220-226 (2007)
	+ Wilkinson, C.J. [The acute effects of zolpidem, administered alone and with alcohol, on cognitive and psychomotor function.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+acute+effects+of+zolpidem%2C+administered+alone+and+with+alcohol%2C+on+cognitive+and+psychomotor+function.)*J Clin Psychiatry*56:309-318 (1995)
* Benzodiazepines
	+ General Benzodiazepines
		- Bramness, J.G. et al. [Testing for benzodiazepine inebriation-relationship between benzodiazepine concentration and simple clinical tests for impairment in a sample of drugged drivers.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Testing+for+benzodiazepine+inebriation-relationship+between+benzodiazepine+concentration+and+simple+clinical+tests+for+impairment+in+a+sample+of+drugged+drivers.) *Eur J Clin Pharmacol* 59:593-601 (2003)
		- Drummer, O.H. [Benzodiazepines – effects on human performance and behavior.](https://www.ncbi.nlm.nih.gov/pubmed/26256485) *Forensic Sci Rev* 14:1-14 (2002)
		- **[NEW]** Høiseth, G. [Impairment due to amphetamines and benzodiazepines, alone and in combination.](https://pubmed.ncbi.nlm.nih.gov/25456327/) *Drug Alcohol Depend* 145:174-9 (2014)
		- **[NEW]** Høiseth, G. [Impairment due to alcohol, tetrahydrocannabinol, and benzodiazepines in impaired drivers compared to experimental studies.](https://pubmed.ncbi.nlm.nih.gov/27327554/) *Traffic Inj Prev* 18:244-250 (2019)
		- van der Sluiszen, N.J.J.M. et al. [Driving performance and neurocognitive skills of long-term users of benzodiazepine anxiolytics and hypnotics.](https://pubmed.ncbi.nlm.nih.gov/31837049) *Hum Psychopharmacol* 34:e2715 (2019)
		- Verster, J.C. et al. [Blood drug concentrations of benzodiazepines correlate poorly with actual driving impairment.](https://www.ncbi.nlm.nih.gov/pubmed/22884949) *Sleep Med Rev* 17:153-159 (2013)
	+ Alprazolam
		- Leufkens, T.R., et al. [Cognitive, psychomotor and actual driving performance in healthy volunteers after immediate and extended release formulations of alprazolam 1 mg.](http://www.ncbi.nlm.nih.gov/pubmed/?term=.++Cognitive%2C+psychomotor+and+actual+driving+performance+in+healthy+volunteers+++++++++after+immediate+and+extended+release+formulations+of+alprazolam+1+mg.) *Psychopharmacology*191:951-959 (2007)
		- Stone, B.T., et al. [Behavioral and neurophysiological signatures of benzodiazepine-related driving impairments.](https://www.ncbi.nlm.nih.gov/pubmed/26635697) *Front Psychol* 6:1799 (2015)
		- Verster, J.C. and Volkerts, E.R. [Clinical pharmacology, clinical efficacy, and behavioral toxicity of alprazolam: a review of the literature.](https://www.ncbi.nlm.nih.gov/pubmed/14978513) *CNS Drugs Rev* 10:45-76 (2004)
	+ Clonazepam
		- Monteiro dos Santos, FM et al. [Pharmacokinetic/pharmacodynamic modeling of psychomotor impairment induced by oral clonazepam in healthy volunteers.](https://pubmed.ncbi.nlm.nih.gov/19730280/) *Ther Drug Monit* 31:566-574 (2009)
		- Wildin, J.D. et al. [Respiratory and sedative effects of clobazam and clonazepam in volunteers.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Respiratory+and+sedative+effects+of+clobazam+and+clonazepam+in+volunteers.) *Br J Clin Pharmac* 29:169-177 (1990)
	+ Lorazepam
		- Clarkson, J.E. et al. [Lorazepam and driving impairment.](http://www.ncbi.nlm.nih.gov/pubmed/15516298) *J Anal Toxicol* 28:475-480 (2004)
		- Daurat, A. et al. [Lorazepam impairs highway driving performance more than heavy alcohol consumption.](https://www.ncbi.nlm.nih.gov/pubmed/24007754) *Accid Anal Prev* 60:31-34 (2013)
	+ Diazepam
		- Boucart, M. et al. [Diazepam impairs temporal dynamics of visual attention.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Diazepam+impairs+temporal+dynamics+of+visual+attention.) *Exp Clin Psychopharmacol* 15:115-122 (2007)
		- Greenblatt, D.J. et al. [A large-sample study of diazepam pharmacokinetics.](http://www.ncbi.nlm.nih.gov/pubmed/?term=A+large-sample+study+of+diazepam+pharmacokinetics.) *Ther Drug Monitor* 11:652-657 (1989)
		- Jones, A.W. et al. [High concentrations of diazepam and nordiazepam in blood of impaired drivers: association with age, gender and spectrum of other drugs present.](https://www.ncbi.nlm.nih.gov/pubmed/15485715) *Forensic Sci Int* 146:1-7 (2004)
		- Jongen, S. et al. [Comparing the effects of oxazepam and diazepam in actual highway driving and neurocognitive test performance: a validation study.](https://www.ncbi.nlm.nih.gov/pubmed/29500585) *Psychopharmacology (Berl)* 235:1283-1294 (2018)

**Narcotic Analgesics**

* General Opioids **(Completed Re-Review in 2024)**
	+ **[NEW]** Cameron-Burr, K.T. et al. [Opioid Use and Driving Performance](https://pubmed.ncbi.nlm.nih.gov/33403571/) *J Med Toxicol* 17:289-308 (2021)
	+ Kress, H.G. and Kraft, B. [Opioid medication and driving ability.](http://www.ncbi.nlm.nih.gov/pubmed/15737803) *Eur J Pain* 9:141-144 (2005)
	+ Stout, P.R and Farrell, L.J. [Opioids: effects on human performance and behavior.](https://pubmed.ncbi.nlm.nih.gov/26256593/) *Forensic Sci Rev* 15:29-59 (2003)
	+ Willhelmi, B.G. and Cohen, S.P. [A framework for "driving under the influence of drugs" policy for the opioid using driver.](https://www.ncbi.nlm.nih.gov/pubmed/22786459) *Pain Physician* 15:ES215-230 (2012)
* Heroin/Morphine
	+ Hobbs G.J. and Knaggs R.D. [Differential effects of morphine and codeine on pupil size: dosing issues.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Differential+effects+of+morphine+and+codeine+on+pupil+size%3A+dosing+issues.) *Anesth Analg*100:598 (2005)
	+ Jenkins, A.J. et al. [Pharmacokinetics and pharmacodynamics of smoked heroin.](http://www.ncbi.nlm.nih.gov/pubmed/7823539) *J Anal Toxicol*18:317-330 (1994)
	+ Jones, A.W. et al. [Driving under the influence of opiates: concentration relationships between morphine, codeine, 6-acetyl morphine, and ethyl morphine in blood.](http://www.ncbi.nlm.nih.gov/pubmed/18430293) *J Anal Toxicol*32:265-272 (2008)
	+ Jones, A.W. et al. [Concentrations of free-morphine in peripheral blood after recent use of heroin in overdose deaths and in apprehended drivers.](https://www.ncbi.nlm.nih.gov/pubmed/21353406) *Forensic Sci Int*215:18-24 (2012)
	+ Knaggs, R.D. et al. [The pupillary effects of intravenous morphine, codeine, and tramadol in volunteers.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+pupillary+effects+of+intravenous+morphine%2C+codeine%2C+and+tramadol+in+volunteers.) *Anesth Analg* 99:108-112 (2004)
	+ Lugo, R.A. and Kern, S.E. [Clinical pharmacokinetics of morphine.](http://www.ncbi.nlm.nih.gov/pubmed/14635822) *J Pain Palliat Care*16:5-18 (2002)
	+ Strand, M.C., et al. [Acute impairing effects of morphine related to driving: A systematic review of experimental studies to define blood morphine concentrations related to impairment in opioid-naïve subjects.](https://www.ncbi.nlm.nih.gov/pubmed/28481682) *Traffic Inj Prev* 18:788-794 (2017)
	+ Tress, K.H. et al. [Degree of tolerance and the relationship between plasma morphine concentration and pupil diameter following intravenous heroin in man.](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1429291/) *Br J Clin Pharmacol* 5:299-303 (1978)
	+ Tress, K.H. and El-Sobky, A.A. [Pupil responses to intravenous heroin (diamorphine) in dependent and non-dependent humans.](http://www.ncbi.nlm.nih.gov/pubmed/760755) *Br J Clin Pharmacol* 7:213-217 (1979)
* Codeine
	+ Amato, J.N. et al. [Effects of three therapeutic doses of codeine/paracetamol on driving performance, a psychomotor vigilance test, and subjective feelings.](https://www.ncbi.nlm.nih.gov/pubmed/23474890) *Psychopharmacology (Berl)* 228:309-320 (2013)
	+ Gasche, Y. et al. [Codeine intoxication associated with ultrarapid CYP2D6 metabolism*.*](http://www.ncbi.nlm.nih.gov/pubmed/15625333)*New Eng J Med* 351:2827-2831 (2004)
	+ Gjerde, H. and Mørland, J. [A case of high opiate tolerance: implications for drug analyses and interpretations.](http://www.ncbi.nlm.nih.gov/pubmed/?term=A+case+of+high+opiate+tolerance%3A+implications+for+drug+analyses+and+interpretations.) *Int J Leg Med* 351:2827-2831 (2004)
	+ Guay, D.R. et al. [Pharmacokinetics of codeine after single- and multiple-oral-dose administration to normal volunteers.](http://www.ncbi.nlm.nih.gov/pubmed?term=pharmacokinetics%20of%20codeine%20after%20single%20and%20multiple-oral-dose%20administration%20to%20normal%20volunteers.&cmd=correctspelling) *J Clin Pharm* 27:983-987 (1987)
	+ Hobbs G.J. and Knaggs R.D. [Differential effects of morphine and codeine on pupil size: dosing issues.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Differential+effects+of+morphine+and+codeine+on+pupil+size%3A+dosing+issues.) *Anesth Analg*100:598 (2005)
	+ Kim, I. et al. [Plasma and oral fluid pharmacokinetics and pharmacodynamics after oral codeine administration.](http://www.ncbi.nlm.nih.gov/pubmed/12194925) *Clin Chem* 48:1486-1496 (2002)
	+ Kirchheiner, J. et al. [Pharmacokinetics of codeine and its metabolite morphine in ultra-rapid metabolizers due to CYP2D6 duplication.](https://pubmed.ncbi.nlm.nih.gov/16819548/) *Pharmacogenomics J* 7:257-265 (2007)
	+ Oyler, J.M. et al. [Identification of hydrocodone in human urine following controlled codeine administration.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Identification+of+hydrocodone+in+human+urine+following+controlled+codeine+administration.) *J Anal Toxicol* 24:530-535 (2000)
	+ Knaggs, R.D. et al. [The pupillary effects of intravenous morphine, codeine, and tramadol in volunteers.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+pupillary+effects+of+intravenous+morphine%2C+codeine%2C+and+tramadol+in+volunteers.) *Anesth Analg* 99:108-112 (2004)
	+ Linnoila, M. and Häkkinen, S. [Effects of diazepam and codeine, alone and in combination with alcohol, on simulated driving.](https://pubmed.ncbi.nlm.nih.gov/4595291/) *Clin Pharmacol Ther* 15:368-373 (1974)
	+ Peacock, J.E. [Changes in pupil diameter after oral administration of codeine.](https://pubmed.ncbi.nlm.nih.gov/3207531/) *Br J Anaesth* 61:598-600 (1988)
* Hydrocodone **(Completed Re-Review in 2025)**
	+ Oyler, J.M. et al. [Identification of hydrocodone in human urine following controlled codeine administration.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Identification+of+hydrocodone+in+human+urine+following+controlled+codeine+administration.) *J Anal Toxicol* 24:530-535 (2000)
	+ Melhem, M.R. et al. [Population pharmacokinetics analysis for hydrocodone following the administration of hydrocodone bitartrate extended-release capsules.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Population+pharmacokinetics+analysis+for+hydrocodone+following+the+administration+of+hydrocodone+bitartrate+extended-release+capsules.) *Clin Pharmacokinet* 52:907-917 (2013)
	+ Molina, D.K. and Hargrove, V.M. [What is the lethal concentration of hydrocodone?: a comparison of postmortem hydrocodone concentrations in lethal and incidental intoxications.](https://pubmed.ncbi.nlm.nih.gov/20407360/) *Am J Forensic Med Pathol* 32:108-111 (2011)
	+ Zacny, J.P. et al. [Profiling the subjective, psychomotor, and physiological effects of a hydrocodone/acetaminophen product in recreational drug users.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Profiling+the+subjective%2C+psychomotor%2C+and+physiological+effects+of+a+hydrocodone%2Facetaminophen+product+in+recreational+drug+users.) *Drug Alcohol Depend* 78:243-252 (2005)
* Oxycodone
	+ Jung, B.F. and Reidenberg, M.M [Interpretation of opioid levels: comparison of levels during chronic pain therapy to levels from forensic autopsies.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Interpretation+of+opioid+levels%3A++Comparison+of+levels+during+chronic+pain+therapy+to+levels+from+forensic+autopsies.) *Clin Pharmacol Ther* 77:324-334 (2005)
	+ Lalovik, B. et al. [Pharmacokinetics and pharmacodynamics of oral oxycodone in healthy human subjects: role of circulating active metabolites.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Pharmacokinetics+and+pharmacodynamics+of+oral+oxycodone+in+healthy+human+subjects%3A++Role+of+circulating+active+metabolites.) *Clin Pharmacol Ther*79:461-479 (2006)
	+ Leow, K.P. et al. [Pharmacokinetics and pharmacodynamics of oxycodone when given intravenously and rectally to adult patients with cancer pain.](http://www.ncbi.nlm.nih.gov/pubmed/?term=.++Pharmacokinetics+and+pharmacodynamics+of+oxycodone+when+given+intravenously+and+rectally+to+adult+patients+with+cancer+pain.) *Anesth Anal*80:296-302 (1995)
	+ Pöyhiä, R. et al. [The pharmacokinetics and metabolism of oxycodone after intramuscular and oral administration to healthy subjects.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+pharmacokinetics+and+metabolism+of+oxycodone+after+intramuscular+and+oral+administration+to+healthy+subjects.) *Br J Clin Pharmacol* 33:617-621 (1992)
	+ Takala, A. et al. [Pharmacokinetic comparison of intravenous and intranasal administration of oxycodone.](http://www.ncbi.nlm.nih.gov/pubmed/9062618) *ACTA Anaesthesiologica Scandinavica* 41:309-312 (1997)
	+ Verster, J.C. et al. [Effects of an opioid (oxycodone/paracetamol) and an NSAID (bromfenac) on driving ability, memory functioning, psychomotor performance, pupil size, and mood.](https://www.ncbi.nlm.nih.gov/pubmed/16772806) *Clin J Pain* 22:499-504 (2006)
	+ Zacny, J.P. and Gutierrez, S. [Characterizing the subjective, psychomotor, and physiological effects of oral oxycodone in non-drug-abusing volunteers.](https://www.ncbi.nlm.nih.gov/pubmed/12955305) *Psychopharmacology (Berl)* 170:242-254 (2003)
* Methadone **(Completed Re-Review in 2025)**
	+ **[NEW]** Bernard, J.P. et al. [Methadone and impairment in apprehended drivers.](https://pubmed.ncbi.nlm.nih.gov/19207356/) Addiction 104:457-464 (2009)
	+ Jones, A.W. [Blood methadone concentrations in living and deceased persons: variations over time, subject demographics, and relevance of coingested drugs.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Blood+methadone+concentrations+in+living+and+deceased+persons%3A+variations+over+time%2C+subject+demographics%2C+and+relevance+of+coingested+drugs.) *J Anal Toxicol* 36:12-18 (2012)
	+ Lenné, M.G. et al. [The effects of the opioid pharmacotherapies methadone, LAAM and buprenorphine, alone and in combination with alcohol, on simulated driving.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+effects+of+the+opioid+pharmacotherapies+methadone%2C+LAAM+and+buprenorphine%2C+alone+and+in+combination+with+alcohol%2C+on+simulated+driving.) *Drug Alcohol Depend* 72:271-278 (2003)
	+ **[NEW]** Soyka, M. et al. [Less impairment on one portion of a driving-relevant psychomotor battery in buprenorphine-maintained than in methadone-maintained patients: results of a randomized clinical trial.](https://pubmed.ncbi.nlm.nih.gov/16160628/) *J Clin Psychopharmacol* 25:490-493 (2005)
	+ Strand, M.C. et al. [Can patients receiving opioid maintenance therapy safely drive? A systematic review of epidemiological and experimental studies on driving ability with a focus on concomitant methadone or buprenorphine administration.](https://www.ncbi.nlm.nih.gov/pubmed/23259516) *Traffic Inj Prev* 14:26-38 (2013)
	+ Strand, M.C. et al. [A clinical trial on the acute effects of methadone and buprenorphine on actual driving and cognitive function of healthy volunteers.](https://pubmed.ncbi.nlm.nih.gov/30515857/) *Br J Clin Pharmacol* 85:442-453 (2019)
	+ **[NEW]** Tsai, T.Y. et al. [Risk of motor vehicle collisions after methadone use: A systematic review and meta-analysis.](https://pubmed.ncbi.nlm.nih.gov/36933540/) Drug Alcohol Depend 246:109832 (2023)
* Fentanyl **(Completed Re-Review in 2024)**
	+ **[NEW]** Chan-Hosokawa, A. and Bierly J.J. [11-Year study of fentanyl in driving under the influence of drugs casework](https://pubmed.ncbi.nlm.nih.gov/34002762/) *J Anal Toxicol* 46:337-341 (2022)
	+ **[NEW]** Harper, C.E. et al. [The impact of fentanyl on DUIDs and traffic fatalities: blood and oral fluid data](https://pubmed.ncbi.nlm.nih.gov/37477181/) 68:1686-1697 (2023)
	+ Kiely, E. and Juhascik, M. [Fentanyl, Acetylfentanyl and Carfentanil in Impaired Driving Cases: A Review of 270 Cases.](https://pubmed.ncbi.nlm.nih.gov/34297097/) *J Anal Toxicol* 45:913-917 (2021)
	+ Rohrig, T.P. et al. [Fentanyl and driving impairment.](https://pubmed.ncbi.nlm.nih.gov/32797151) *J Anal Toxicol*45:389-396 (2021)
* Buprenorphine **(Completed Re-Review in 2025)**
	+ Edwards, L.D. [Buprenorphine in Wisconsin drivers: concerns for impairment?](https://www.ncbi.nlm.nih.gov/pubmed/31436286) *J Anal Toxicol* 43:644-650 (2019)
	+ Elkader, A. and Sproule, B. [Buprenorphine: Clinical pharmacokinetics in the treatment of opioid dependence.](http://www.ncbi.nlm.nih.gov/pubmed/15966752) *Clin Pharmacokinet*44:661-680 (2005)
	+ Kuhlman, J.J. et al. [Human pharmacokinetics of intravenous, sublingual, and buccal buprenorphine.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Human+pharmacokinetics+of+intravenous%2C+sublingual%2C+and+buccal+buprenorphine.) *J Anal Toxicol* 20:369-378 (1996)
	+ **[NEW]** Kuhlman, J.J. et al. [Buprenorphine prevalence in DUID cases in southwestern Virginia: Case studies and observations.](https://pubmed.ncbi.nlm.nih.gov/33186447/) *J Anal Toxicol* 46:89-98 (2022)
	+ Lenné, M.G. et al. [The effects of the opioid pharmacotherapies methadone, LAAM and buprenorphine, alone and in combination with alcohol, on simulated driving.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+effects+of+the+opioid+pharmacotherapies+methadone%2C+LAAM+and+buprenorphine%2C+alone+and+in+combination+with+alcohol%2C+on+simulated+driving.) *Drug Alcohol Depend* 72:271-278 (2003)
	+ **[NEW]** Soyka, M. et al. [Less impairment on one portion of a driving-relevant psychomotor battery in buprenorphine-maintained than in methadone-maintained patients: results of a randomized clinical trial.](https://pubmed.ncbi.nlm.nih.gov/16160628/) *J Clin Psychopharmacol* 25:490-493 (2005)
	+ Strand, M.C. et al. [A clinical trial on the acute effects of methadone and buprenorphine on actual driving and cognitive function of healthy volunteers.](https://www.ncbi.nlm.nih.gov/pubmed/30515857.) *Br J Clin Pharmacol* 85:442-453 (2019)
* Tramadol **(Completed Re-Review in 2025)**
	+ Knaggs, R.D. et al. [The pupillary effects of intravenous morphine, codeine, and tramadol in volunteers.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+pupillary+effects+of+intravenous+morphine%2C+codeine%2C+and+tramadol+in+volunteers.) *Anesth Analg* 99:108-112 (2004)
	+ Clarkson, J.E., et al. [Tramadol (Ultram) concentrations in death investigation and impaired driving cases and their significance.](https://www.ncbi.nlm.nih.gov/pubmed/15461118) *J Forensic Sci* 49:1101-1105 (2004)
	+ Nakhaee, S., et al. [A review on tramadol toxicity: mechanism of action, clinical presentation, and treatment.](https://link.springer.com/article/10.1007/s11419-020-00569-0) *Forensic Toxicol* 39:293-310 (2021)
	+ **[NEW]** Zacny, J.P. [Profiling the subjective, psychomotor, and physiological effects of tramadol in recreational drug users.](https://pubmed.ncbi.nlm.nih.gov/16005162/) *Drug Alcohol Depend* 80:273-278 (2005)

**General Drugged Driving References**

* Augsburger, M. et al. [Concentration of drugs in blood of suspected impaired drivers.](http://www.ncbi.nlm.nih.gov/pubmed/15923096) *Forensic Sci Int* 153:11-15 (2005)
* Baselt, R.C. *Drug Effects on Psychomotor Performance*, Foster City, California:Biomedical Publications, 2001
* Baselt, R.C. *Disposition of Toxic Drugs and Chemicals in Man (12th ed.)*, Foster City, California: Biomedical Publications, 2020
* Moffat A.C., Osselton M.D., Widdop B., Watts J. eds. *Clarke's Analysis of Drugs and Poisons* *(4th ed.)*, Grayslake, IL:Pharmaceutical Press, 2011
* Dassanayake, T. et al. [Effects of benzodiazepines, antidepressants and opioids on driving: a systematic review and meta-analysis of epidemiological and experimental evidence.](https://www.ncbi.nlm.nih.gov/pubmed/21247221) *Drug Saf* 34:125-156 (2011)
* **[NEW]** [Drugs and Human Performance Fact Sheets](https://rosap.ntl.bts.gov/view/dot/78924), National Highway and Safety Administration, DOT HS 813 650 (2024)
* Gjerde, H.et al. [Driving under the influence of non-alcohol drugs - an update part 1: epidemiological studies.](https://www.ncbi.nlm.nih.gov/pubmed/26227253) *Forensic Sci Rev* 27:89-113 (2015)
* Jones, A.W. et al. [Concentrations of scheduled prescription drugs in blood of impaired drivers: considerations for interpreting the results.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Concentrations+of+Scheduled+Prescription+Drugs+in+Blood+of+Impaired+Drivers%3A+Considerations+for+Interpreting+the+Results.) *Ther Drug Monitor* 29:248-260 (2007)
* Kay, G.G. and Logan B.K., [Drugged driving expert panel report: a consensus protocol for assessing the potential of drugs to impair driving](https://www.nhtsa.gov/sites/nhtsa.gov/files/811438.pdf), NHTSA, DOT HS 811 438 (2011)
* Leung, S.Y. [Benzodiazepines, opioids and driving: an overview of the experimental research.](https://www.ncbi.nlm.nih.gov/pubmed/21545558) *Drug Alcohol Rev* 30:281-286 (2011)
* Levine, B. and Kerrigan, S. eds. *Principles of Forensic Toxicology (5th ed.)*, Switzerland:Springer International Publishing, 2020
* Mills, K.C. et al. [The influence of stimulants, sedatives, and fatigue on tunnel vision: risk factors for driving and piloting.](https://www.ncbi.nlm.nih.gov/pubmed/11592671.) *Hum Factors* 43:310-327 (2001)
* Penning, R. et al. [Drugs of abuse, driving and traffic safety.](https://www.ncbi.nlm.nih.gov/pubmed/20088818) *Curr Drug Abuse Rev* 3:23-32 (2010)
* Rapoport, M.J. and Baniña, M.C. [Impact of psychotropic medications on simulated driving: a critical review.](https://www.ncbi.nlm.nih.gov/pubmed/17521229) *CNS Drugs* 21:503-519 (2007)
* Schulz, M. el al. [Revisited: Therapeutic and toxic blood concentrations of more than 1100 drugs and other xenobiotics.](https://pubmed.ncbi.nlm.nih.gov/32375836/) *Crit Care* 24:195 (2020)
* Verster, J.C. et al. [Residual effects of sleep medication on driving ability.](https://pubmed.ncbi.nlm.nih.gov/15233958/) *Sleep Med Rev* 8:309-325 (2004)