

Cannabis and Driving

An extract from Cannabis: 'A General Survey of its Harmful Effects'

Mary Brett updated January 2019

Tests of car-driving on tracks free of other vehicles by Klonoff 1974, Hansteen 1976 and Attwood 1981, using low or even very low doses of THC, found slight to moderate impairment of driving ability.

Cannabis intoxication affects mental functions in the same way, whether the user is just starting, or is a regular smoker. Moscovitz, a leading researcher in this field, reported in 1985 that, even in *moderate doses*, cannabis use impairs the functions of co-ordination, tracking (following a randomly moving obstacle with an instrument), perception and vigilance. He proceeded to test drivers on car simulators and confirmed his findings. Moscovitz, Miller and Branconnier (1983) all recorded a deterioration of the ability to assess time accurately and an impairment of short-term memory. Although probably not of prime importance in driving cars, these deficiencies would be of vital significance in an airline pilot. Smiley (1986) using higher doses, suddenly placed an obstacle in the path of drivers on simulators and found several were unable to avoid a crash.

In an experiment on reaction times, Wilson and others in 1993 demonstrated that a clear association exists between the dose of cannabis (15-35mg) and reaction times.

In 1994, WHJ Robbe, of The University of Limburg in Maastricht, studied drivers who had taken 20 milligrams of THC - a very low dose. A single one-gram cigarette today can contain anything up to 200 milligrams. He found a significant deterioration in driving ability, especially keeping the car steady in the middle of a lane and a constant distance from the verge. He also discovered that, comparing the 20mg cannabis dose to a blood alcohol level of 1g/litre of blood (just over the legal limit) in identical studies, the results were very close as regards the deterioration in each variable.

Several researchers, including Robbe and Capel and Pliner 1973, have found on doing these kinds of experiments that, if strongly motivated, drivers can, barring distractions or unexpected complications, compensate for some of the impairments. The dangers posed by cannabis in a *real* situation, may therefore be underestimated.

And in 1995 Chesher tested car-driving ability in placebo-controlled studies in real traffic situations and dose-related performance decrements *were* recorded. An American study in 1988 by Carl Soderstrom et al, reported that, although 9 to 10 times as many people in the United States drink alcohol, cannabis is implicated in a similar number of accidents.

Janowsky used experienced airline pilots on flight simulators to investigate the problem. In 1976, despite the low dose (eight milligram) involved, the subsequent deterioration in short-term memory caused them to make mistakes. Confirmation came in 1991 in a well-publicised study by Leirer et al of Stanford, California. Using a dose of 20 milligrams THC, in a double-blind experiment, they found that the performance was worse in all aspects of flying, even up to and beyond 24 hours after consumption, and the pilots were totally unaware of a problem.

Someone taking a joint today *should not* be driving tomorrow.

Tests on driving were carried out by a BBC team for a Five Live Report, "The Drug Drivers" on 30th December 2001. Radar equipment linked to satellites monitored the driving skills of a 32-year-old woman before and after she smoked a joint. There was a marked decline of her reaction times and in her overall competence. At 66 mph, she took on average of 4.6 seconds to come to a halt over 270 feet. After a joint her time increased to 5.35 seconds and the stopping distance to 308.5 feet. A sobriety test was failed almost an hour later.

Analysing blood samples from accident victims is an approach that some researchers have used. In 1988, Dr Dale Gieringer found that "Significant blood levels of THC occur 3 to 5 times more frequently in fatally injured drivers than in the normal population".

In 1980 Warren et al, researching in Ontario, found that those who drove under the influence of cannabis were almost twice as likely to be involved in an accident.

In 1990 this information was up-dated by Cimbura and others. He found that, of 1169 fatally injured drivers and 225 pedestrians between 1982 and 1984 in Ontario, THC was present in the blood of 10.9% of the drivers and 7.6% of the pedestrians, ethanol in 57.1% of drivers and 53.3% of pedestrians. This is a threefold increase in blood THC levels since the 1980 study.

1999 saw a report in The Canadian Journal of Public Health by Walsh et al, stating that cannabis is the most frequent illicit drug found in drivers killed or injured in motor vehicle collisions in Ontario, with 22.8% of drivers admitting driving under its influence.

Nearer home in Scotland in the same year, 1999, in a four-year period from 1995 to 1998, the Department of Forensic Medicine and Science (Seymour and Oliver) received 752 samples from drivers suspected of driving under the influence of drink or drugs in the Strathclyde region. Drugs were detected in 68% and 90% of blood and urine samples respectively. Cannabis was the most frequent occurring in 39% of all positive blood samples.

Analysis of blood to quantify the amount of the drug “needed” to make driving hazardous was carried out in 1993 in a study of truck driver fatalities by Crouch and others. They concluded that marijuana use was a factor in all cases where the delta-9-THC content exceeded 1.0ng/ml of blood and alcohol where the blood/alcohol concentration was 0.04% wt/vol or greater. In 50 of 56 cases where psychoactive drugs or alcohol were found, impairment due to substance abuse contributed to the fatal accident.

Ramaekers et al in 2004 using more modern techniques for blood analysis, found an ever-stronger link between cannabis consumption before or during driving and an increased risk of accidents than previously thought. He found that drivers under the influence were 3 to 7 times more likely to be the cause of accidents in which they were involved.

Researchers have repeatedly warned that, since alcohol affects the psychomotor functions fairly quickly, and cannabis the cognitive ones, the combination will undoubtedly be extremely dangerous, especially in a complex traffic situation. In 2002 Ramaekers team carried out a study and showed that moderate amounts of alcohol and moderate amounts of cannabis can together cause a very strong increase in the risk of making a driving error.

Differences in countries are apparent in this respect. In a 1986 USA survey by McBay, 75% of a sample of drivers involved in accidents had cannabinoids and alcohol in their blood. In Australia only 50% of the surviving drivers of dangerous or fatal collisions had this combination (Road Safety 1995) and in Norway (Gjerde 1991) 56% of drug impaired drivers were negative for alcohol but positive for THC.

In their 1997 report on cannabis the WHO said that cannabis increases the risk of motor vehicle accidents and the risk is much higher with a combination of cannabis and alcohol.

A French study in 2003 by Mura et al took blood from 900 injured road traffic accident victims and compared it with blood from 900 controls at the same A and E departments but not for traffic accidents. The most common drug detected was alcohol but for cannabis alone (no other drug in the system) 10% of drivers tested positive and only 5% of the controls.

The BMJ in December 2005 carried a paper by French scientists led by Bernard Laumon. From 10,748 fatal car crashes between 2001 and 2003 they investigated the 6766 drivers held to be responsible for the accident. The controls were 3006 of the other drivers. Taking into account the age of the vehicle and age of driver, the researchers concluded that cannabis caused a significant number of the fatalities. 681(7%) tested positive for cannabis and 2096 (21.4%) for alcohol. Cannabis was deemed directly responsible for 2.5% and alcohol 29% of the crashes. A combination of cannabis and alcohol was held to be 16 times more risky than either drug alone.

Another factor to consider is that, cannabis users erroneously think they have “sobered up” long before they really have, so they may well drive before they should. In a survey at Glasgow University, at the

beginning of 2001, it was reported that one in 10 young people between 17 and 39 regularly drove under the influence of drugs, 75% after smoking cannabis. They were also quite happy to take a lift from friends who had just taken drugs. A huge six-fold increase in road crash victims found with illegal drugs in their systems sparked off this study of 1000 drivers. One “spliff” is thought by some experts to have the same effect as the amount of alcohol needed to just exceed the drink-drive limit. The biggest problem was among men between the ages of 20 and 24. There are now increased calls for reliable roadside testing for drugs to be introduced. The difficulty here is to ascertain when the drug was actually taken. In the case of cannabis, the consumption of a joint only once a month or even less frequently, will give consistently positive results. Blood levels of THC may prove useful in this respect.

A month later, an Internet study was conducted for ‘Max Power’ a motoring magazine for young people, especially aimed at men between 17 and 24. This revealed an even more alarming 27% of youngsters regularly driving at least once a week while under the influence of drugs; most of them boasting that their driving skills actually improved, 36% confessed to a monthly occurrence. Cannabis was, by far, the commonest drug taken. The Daily Mail reported on 23rd April 2006 that another survey for “Max Power” had revealed a huge increase in these figures. Nearly half of the 447 youngsters interviewed admitted to driving regularly after having taken drugs like ecstasy or cocaine, one in five said it was a daily occurrence. They were confident of escaping detection because of the lack of roadside tests which are not due to be in use for about 2 years.

An analysis of the 2003 Monitoring the Future and Census Bureau data in the USA showed the following results: Out of nearly 4 million high school seniors in America, it was estimated that approximately one in six i.e. 600,000 drove under the influence of marijuana, nearly the same as for alcohol, 640,000. An estimated 38,000 reported they had crashed while under its influence in 2001, 46,000 while affected by alcohol.

Many youngsters seemed totally ignorant of the law, they were not aware that it is an offence to drive under the influence of drugs, as it is with alcohol.

In 2002 a paper from New South Wales (O’Kane et al) in Australia reported, “The incidence of driving while affected by cannabis is rising in parallel with increasing cannabis use in the community. Young drivers are at particular risk. Improvements in research, methodology, technical and laboratory testing methods have occurred in the last 10 years. ...Studies now show that cannabis has a significant impairing effect on driving when used alone and that this effect is exaggerated when combined with alcohol. Of particular concern is the presence of cannabis as sole psychiatric drug in an increasing number of road fatalities”.

2004 Raemakers et al did a review of driving and dose-related risk of crashes after cannabis use. Surveys that established recent use of cannabis by direct measurement of THC in the blood showed that THC positives, particularly at high doses are about 3 to 7 times more likely to be responsible for the crash as compared to drivers with no alcohol or THC in the system. Together...recent use of cannabis may contribute to the crash where past use does not. ...similar findings concerning the combined use of alcohol and cannabis in traffic. Combined use of THC and alcohol produced severe impairment of cognitive, psychomotor, and actual driving performance in experimental studies and sharply increased the crash risk. Up to a dose of 300ug/kg THC the risk is found to be equivalent to risk at the legal driving limit for alcohol.

An Economic and Social research Council team led by Dr Philip Terry of Birmingham University released a study on 27th January 2004. Most regular cannabis users admitted to driving under the influence of the drug in spite of being aware that it impairs their performance. 74% had taken a car or motorbike on the road while feeling stoned, 70% believed it had a bad effect on their driving, but 41% felt their actions were acceptable. 100 frequent users (4 to 7 times a week) and 90 casual users (no more than 4 days a month) were questioned. One third of the frequent users were willing to drive even when they considered themselves to be “very high”. Nearly 80% said roadside testing would be a deterrent although one in eight had been stopped while under its influence and none had been tested for intoxication by the drug or charged for being under its influence.

A bulletin from The New South Wales Bureau of Crime Statistics and Research Number 87 in September 2005 by Jones et al, concluded that “Random drug testing appears to act as a more effective

deterrent against drug-driving than an increase in the severity of sanctions or providing factual information about the risks associated and the behaviour”.

The Monash University Accident Research Centre in Australia produced a report in 2004 reviewing the epidemiological, driving performance and drug screening literature as it relates to cannabis and road safety.

Data for fatally injured drivers between 1997 and 1999 show that 8.5% of those tested were positive for THC, the psychoactive component. They were found to be significantly more culpable than drug-free drivers, even more so when the cannabis was combined with alcohol. They reported, “Recent on-road and simulator studies have set the bench mark for cannabis and driving research. There is no doubt that recent research is continuing to show that cannabis, both alone and with alcohol, impairs a range of measures of driving performance. The predominant form of impairment observed after smoking cannabis alone is an increase in lane-weaving behaviour....also... increased variability in headway to a lead vehicle. This is an important finding because it is commonly interpreted as reflecting the ability to perceive changes in the relative velocities of other vehicles and ability to adjust own speed accordingly, and is suggestive of impaired perceptual abilities. When cannabis is combined with alcohol, variability of headway is again increased, and variability in lane-weaving behaviour is increased to a greater extent than for cannabis alone. This is again indicative of impaired performance. Furthermore drivers with both cannabis and alcohol take significantly longer to react to changes in the speed of other vehicles. The frequency of visual search for traffic at intersections has been found to be similar for placebo, alcohol alone and cannabis alone, but reduced significantly when alcohol and cannabis are combined.drivers are less able to respond to peripheral traffic while maintaining performance on the central driving task”.

2005 Asbridge et al looked at adolescent Canadians and cannabis use before driving. ‘While the current findings cannot confirm whether DUIC (Driving Under the Influence of Cannabis) was directly responsible for a MVC (Major Vehicle Crashes), adolescents who used cannabis in the one hour prior to driving were more likely to be involved in MVCs. The risk was around double those who didn’t use cannabis.

Dr Katherine Papafotiou told a seminar at Swinburne University of Technology, Victoria, Australia on October 13th 2006 that while cannabis manifests itself differently to alcohol, it can be equally dangerous when used before driving. Cannabis users were more likely to lane-weave and stop too close to vehicles in front of them. She also found that driver errors occurred more often when alcohol and cannabis were both present. The 3-year study tested 80 Victorians between 21 and 35 who were either regular or irregular users.

2007, Khiabani HZ et al found that THC affects the cognitive and psychomotor skills of drivers. These effects could last longer than a measurable concentration of THC in the blood. Culpability studies have recently demonstrated an increased risk of becoming responsible in fatal or injurious traffic accidents even with low blood concentrations of THC. It has also been demonstrated that there is a correlation between the degree of impairment, the drug dose and the THC blood concentration.

Another Australian study in August 2007 by Ch’ng and others found that cannabis was the most frequently found drug in the systems of motor vehicle drivers presenting to an adult major trauma centre in Victoria. The blood of 436 victims was analysed, 46.7% contained metabolites of cannabis, 15.6% benzodiazepines, 11% opiates, 4.1% amphetamines, methadone 3% and cocaine 1.4%. THC was found almost exclusively in the 15 to 44 year old age group. “Drug usage found in this group of injured drivers was disturbingly high”.

NIDA (National Institute on Drug Abuse) in the USA funded a study on drugs, including alcohol, and driving published in November 2007. In 2006, 30% of high school seniors reported driving after drinking heavily or using drugs, or being a passenger in a car where the driver had been drinking heavily or using drugs, at least once in the previous 2 weeks. Although the numbers reduced between 2001 and 2003, declining from 35 to 31%, after 2004 it had leveled off. In 2006, 13% had driven after using marijuana. Vehicle accidents are the leading cause of death among those aged 15 to 20.

2008 The RAC Foundation reported the results of a survey of more than 2000 users of Facebook. It was looking at texting with a mobile phone while driving. 45% of UK drivers use SMS (Short message services) while driving. Particularly the young. They commissioned TRL (Transport

Research Laboratory) to study the level of impairment caused by texting while driving. TRL driving simulator was used, as it had been previously for alcohol, cannabis and mobile phone conversations. 17 young people between 17 and 24 were used. Reaction times to trigger stimuli were 35% lower when texting, compared with alcohol, 12% and cannabis 21%. Texters did reduce the speed but were more likely to stray into adjacent lanes and the speed slowdown didn't help.

An EMCDDA report on drug use and driving December 2008 found that:
Cannabis can have a detrimental effect on driving ability as it impairs some cognitive and psychomotor skills necessary for driving.
Most of the effects increase in a dose-dependent manner.
Drivers are aware of the impairment but can only partially compensate.
Alcohol with cannabis causes additional impairment.
Chronic use can lead to performance deficiencies that last longer than intoxication and worsen with frequency and length of use.
There is an increased risk of being involved in an accident and this is worsened with the combination with alcohol. Use of either drug alone is less risky.

2008, Ronen and others assessed the effects of 2 (13mg and 17mg) doses of THC relative to alcohol (0.05% BAC) on driving performance, physiological strain, and subjective feelings. 14 healthy students, all recreational cannabis users took part. Both levels of THC cigarettes significantly affected the subjects in a dose-dependent manner. The moderate dose of alcohol and the low THC dose were equally detrimental to some of the driving abilities, with some differences between the 2 drugs. THC primarily caused elevation in physical effort and physical discomfort during the drive while alcohol tended to affect sleepiness levels. After the THC administration subjects drove significantly slower than in the control condition, while after alcohol ingestion, subjects drove significantly faster than the controls. No THC effects were observed after 24 hours on any of the measures.

2010 June 2nd Alan Crancer conducted a study into traffic deaths in California from the use of marijuana. He found that the largest increase in fatalities in fatal crashes where the driver tested positive for marijuana occurred over the 5 years following the establishment of the medical marijuana programme in January 2004. There were 1240 fatalities under these circumstances for the 5 years compared to 631 fatalities for the 5 years before, an increase of almost 100%. He suggested that the TC2010 (Regulate, Control and Tax Cannabis Act) initiative might triple the number of marijuana-related deaths on California's highways.

2010 Beirness and Beasley carried out a roadside survey of alcohol and drug use among drivers in British Columbia. 1533 vehicles were selected. 89% of drivers provided a breath sample and 78% a sample of oral fluid. They found: 10.4% tested positive for drugs, 8.1% had been drinking, 15.5% tested positive for alcohol, drugs or both. Cannabis and cocaine were the commonest drugs found. Conclusions: 'The finding that drug use is more common than alcohol use among drivers highlights the need for a unique and separate societal response to the use of drugs by drivers commensurate with the extent of safety risks posed to road users. The observed differences between driving after drug use and driving after drinking have implications for enforcement and prevention'.

The increasing toll of accidents caused by drugged drivers is well publicised in the press. Recent reports include the death of a four-year old girl by a driver who had earlier smoked 2 cannabis joints. Barnaby Pearce 19, driving at almost 80 mph in a 60 mph zone, smashed into the side of a car driven by the girl's grandfather (Daily Mail 19/8/05). Another 19 year old, Mitch Treliving killed himself and 7 other people in a head-on crash after driving at 100mph and losing control. His airborne BMW landed on a Land Rover on the opposite carriageway. A pathologist said there were trace amounts of alcohol in his blood but more significant levels of cannabis (Daily Mail 14/4/05). And David Whitnall 26, a self-confessed user of skunk, almost daily since his teens, ploughed into the back of a Fiat at 120mph while steering his sports car with his knees. He killed a woman and severely injured her husband. He was given 6 years in prison and a 10-year ban. Skunk was found in his possession (Times 3/2/06). The driver of a speedboat that killed a 2 year-old British boy on a beach in the Bahamas in 2002 has tested positive for cannabis. Blood and urine samples were taken at the time but never tested. When a Metropolitan police team tested them much later, the facts came to light. He also was without a proper licence or insurance. James Bain has not yet been prosecuted over the death (Daily Mail 07/01/07). The pilot of a 1946 Piper J3 Cub in Walnut Ridge Little Rock in America was found to have

enough marijuana in his system that may have contributed to an accident which killed himself and one passenger
(Associated Press 2007, <http://www.todaysthv.com/printfullstory.aspx?storyid=41149>).

2011 Li and others looked at mandatory testing and aviation accidents in the USA. 'The odds of accident involvement for employees who tested positive for drugs was almost 3 times the odds for those who tested negative.

2011 June Romano et al found in the US that, of those who died in a crash, about 25% tested positive for drugs. The most common were marijuana and stimulants like cocaine and amphetamines. Of drivers simply randomly pulled over, 14% tested positive. This suggests that drugs do contribute to road deaths as the presence was almost twice as high among those killed. 44,000 fatally injured drivers in the USA were studied between 1998 and 2009. Stimulants were linked to all types of crashes – speeding, ignoring other laws, inattention or not using seatbelts. Marijuana linked with speeding and non belt use.

2011 Mu-Chen and others produced a review paper for vehicle crashes for users of marijuana. 9 epidemiologic studies were examined in the past 2 decades. They found that drivers who test positive for marijuana or drive within 3 hours of taking it are more than twice as likely to be involved in a crash than non-users. The greater the amount of marijuana compounds in the urine, also the more frequent self-reported marijuana use were both associated with a greater risk of a vehicle accident. 28% of drivers who died in an accident and more than 11% of drivers in general, tested positive for non-alcohol drugs, most commonly cannabis.

2012 February SADD (Liberty Mutual Insurance and Students Against Destructive Decisions) commissioned a report into teens driving under the influence of marijuana. Nearly 1 in 5 said they had driven after smoking the drug. Almost 2,300 11th and 12th graders were studied. A growing percentage do not see marijuana as a distraction. More than a third of those who had driven after smoking failed to acknowledge their driving may have been impaired. The figure is higher than those who drove after drinking alcohol (13%).

2012 Ashbridge et al reviewed the literature on vehicle accidents. *Results.* We selected nine studies in the review and meta-analysis. Driving under the influence of cannabis was associated with a significantly increased risk of motor vehicle collisions compared with unimpaired driving. *Conclusions.* Acute cannabis consumption is associated with an increased risk of a motor vehicle crash, especially for fatal collisions. This information could be used as the basis for campaigns against drug impaired driving, developing regional or national policies to control acute drug use while driving, and raising public awareness.

2012 Bosker and others looked at the effects of medicinal THC (Dronabinol) on driving performance. They found that Dronabinol impairs driving performance in occasional and heavy users in a dose-dependent way, but to a lesser degree in heavy users due possibly to tolerance. The Standard Field Sobriety Test is not sensitive enough to clinically relevant driving impairment caused by oral THC.

2013 Bergamaschi et al investigated the effects of cannabis on driving skills. 30 male chronic daily cannabis smokers lived in a secure research unit for up to 33 days. Blood was collected daily. 27 of the 30 were THC positive on admission. Only 1 of 11 participants was negative at 26 days. 2 of 5 remained positive for 30 days. Cannabis is second only to alcohol for causing impaired driving and motor vehicle accidents. For the first time these results show that cannabinoids can be detected in blood of chronic daily cannabis smokers during a month of sustained abstinence. This is consistent with the time course of persisting neurocognitive impairment reported in recent studies and suggests that establishment of 'per se' THC legislation might achieve a reduction in motor vehicle injuries and death.

2013 Battistella et al Investigated how cannabis smoking affects skills necessary for driving. In conclusion, we have shown that in occasional smokers cannabis globally altered the activity of the main brain networks involved in cognition despite the low THC concentrations. Subjects might be more attracted by intrapersonal stimuli ("self") instead of orienting attention to task performance, and this results in an insufficient allocation of task-oriented resources. Effects on BOLD (Blood Oxygen Level Dependent) response were associated with the subjective evaluation of the state of confusion. By contrast, we failed to find any quantitative correlation between the THC levels measured in whole

blood and either the BOLD signal or the psychomotor performance. These results bolster the “zero tolerance policy” that prohibits the presence of any amount of THC in the blood while driving.

2013 June Dupont wrote a paper ‘Marijuana Use is a Serious Highway Safety Threat: 5ng/ml Marijuana Impairment Limits Give Drivers a Free Pass to Drive Stoned.

2013 SAM (Smart Approaches to Marijuana, source Dr Fiona Couper, WA state toxicologist) looked at impaired driving trends for Marijuana in Washington State. In 2009-10 the percentage went down to – 1.1%. 2010-11 it was +6.3%, 2011-12 –4.6% and 2012-13 it jumped to a huge 50.8%

2013 Li et al investigated 737 cases where drivers had been involved in fatal road crashes in 2007 controls (7719) were participants of the 2007 National roadside Survey of Alcohol and Drug Use by drivers. 31.9% of the cases and 13.7% of the controls tested positive for at least one non-alcohol drug. The estimated odds ratio (OR) of fatal crash involvement associated with specific drug categories were 1.83 for marijuana, 3.03 for narcotics, 3.57 for stimulants and 4.83 for depressants. Drivers who tested positive for both alcohol and drugs were at substantially heightened risk relative to those using neither alcohol or drugs (OR 23.24).

Mail Online January 16th 2014 Testing for cannabis will begin this year. One in nine 17-24 year olds have admitted driving after taking drugs. Eleven police forces will try the ‘SPITALYSER’. Drug users are 50 times less likely to be convicted than drunks. Offenders will get an automatic 12-month ban as well as facing 6 months in jail and a £5,000 fine.

2014 Brady and Li discovered a sharp rise in drugged driving fatalities. The rate has tripled for those who tested positive for marijuana. Of 23,591 who were killed within an hour of the crash, 39.7% tested positive for alcohol, and 24.8% for other drugs. For marijuana, rates rose from 4.2% to 12.2% over the period of 1999 to 2010. This substantial increase in the presence of marijuana was found across all groups and both sexes.

2014 Terry-McElrath et al investigated unsafe driving among US High School Seniors. The highest rate of unsafe driving was associated with simultaneous use of alcohol and marijuana.

2014 May Whitehill et al found that driving and riding underage is common among marijuana using college students. Past 28 day use of only marijuana was associated with a 6.4 fold increase risk of driving after substance abuse.

2014 July Salomonsen-Sautel and others looked at trends in fatal vehicle crashes before and after marijuana commercialisation in Colorado. In Colorado where medical marijuana has been available since 2009, the trend in positive testing drivers fatally injured in accidents doubled. No increase was seen in states without medical marijuana or people who tested positive for alcohol.

2014 National Transportation Safety Board conducted a survey on pilots and drugs. They found in 2011 that 40% of all pilots killed in non-commercial airplane crashes in recent years have medication in their systems – the most common being antihistamines and heart medications. Illicit drugs were found in nearly 4% of the deceased pilots. This was up from 10% in the 90s. 6,677 killed pilots between 1990 and 2012 were looked at. Some 3.8% of deceased pilots tested positive for illegal drugs between 2008 to 2012, up from 2.3% in 1990 to 1997. Marijuana was by far the commonest illicit drug found.

2015 Jan Keyes et al looked at driving fatalities in states of the USA. Alcohol, marijuana or both were involved in half of young driver fatalities from 1999-2011. 7,191 fatal accidents involving drivers between 16 to 25 from 9 states, California, Connecticut, Hawaii, Illinois, New Hampshire, New Jersey, Rhode Island, Washington State and West Virginia. More than half the crashes occurred in California. 50.3% had used alcohol, marijuana or both. Of these, 36.8% were under the influence of alcohol, 5.9% marijuana alone and 7.6% had used both substances. . The minimum legal drinking age was associated with a 14% increased risk of alcohol use, a 24% decreased risk of marijuana use, and a 22% increased risk of alcohol plus marijuana use.

2015 Berning et al of the NHTSA (USA National Highways Traffic Safety Administration) found that drinking and driving is falling, but use of illegal drugs is rising. The number of weekend nighttime drivers with evidence of drugs in their system climbed from 16.3% in 2007 to 20% in 2014. The number of drivers with marijuana in their systems grew by nearly 50%.

2015 May, Pollini et al looked at the effects of marijuana decriminalisation on California drivers. They found a statistically significant increase in the prevalence of cannabinoids among fatally injured drivers in 2012 (17.8%) compared to the pre-decriminalization period 2008-2010 (11.8%) The adjusted odds of testing positive for cannabinoids were also significantly higher in 2012.

2015 May, Woodall et al investigated drug driving in fatal motor vehicle collisions, in Ontario in a one year period. Of the 229 cases included in the study, 56% were positive for alcohol and/or drugs. After alcohol, cannabis was the most frequently encountered substance (27%), followed by benzodiazepines (17%) and antidepressants (17%).

2015 Hartman et al looked at cannabis effects on driving lateral control with and without alcohol. SDLP (Standard Deviation of lateral Position) was measured. SDLP was a sensitive cannabis-related lateral control impairment measure. Driving during blood THC 8.2ug/L increased SDLP similar to notably-impairing alcohol concentrations. Concurrent alcohol and cannabis produced additive rather than synergistic effects.

2015 GHSA (Governors Highway safety Association) in the USA has just reported on drug driving. Drivers are almost as likely to be under the influence of marijuana or prescription drugs as alcohol. Drunk driving is declining as drug driving shows a steady increase. Data from fatal crashes suggests that nearly 40% of victims tested had had drugs in their system, a third testing positive for marijuana.

2015 Ewing and others looked at early substance use and subsequent DUI in adolescents. At age 12, adolescents with more positive beliefs about cannabis and more ability to resist marijuana offers, had significantly higher risk of DUI/RWDD(Riding with Drinking Driver) 4 years later. At 14, youth with more past month alcohol use, positive beliefs re marijuana, exposure to peer AM (Alcohol and Marijuana) use and family marijuana use, had a higher risk of DUI/RWDD at age 16.

2015 (October) Washington Traffic Safety Commission Report:

In 2014, 84.3% of drivers, testing +ve for cannabinoids were +ve for THC compared with 44% in 2010. Among the 75 drivers involved in fatal crashes testing +ve for THC, approximately half (38) exceeded the 5ng/ml THC per se limit. The frequency of drivers, +ve for THC alone or in combination with other drugs/alcohol (75 drivers) was highest in 2014 compared with the previous 4-year average of 36.

Among drivers in fatal crashes testing for only THC or carboxy-THC, the largest proportion are aged 16-25, and the crashes occurred mostly in daytime and on urban roads (58.9%). Over 70% were in multiple-unit fatal crashes. The most frequently reported driver error among drivers with only THC was lane deviation (12.5%) and overcorrecting (8.9%). Most alcohol related fatal crashes are due to speeding.

2016 NPCC (National Police Chief's Council) ran a 'Getting drugs off our roads' Christmas drink and drug drive campaign. The campaign ran from 1st to 31st December 2015 and saw 1888 drug screening devices administered by officers. Nearly 50% of those stopped were found to be under the influence of drugs. More people were detected in December than in the whole of 2014.

2016 Brubacher et al looked at the prevalence of alcohol and drug use in injured British Columbia drivers. Results '1097 drivers met inclusion criteria. 60% were aged 20–50 years, 63.2% were male and 29.0% were admitted to hospital. Cannabis was the second most common recreational drug after alcohol: cannabis metabolites were present in 12.6% (10.7% to 14.7%) of drivers and we detected Δ -9-tetrahydrocannabinol (Δ -9-THC) in 7.3% (5.9% to 9.0%), indicating recent use. Males and drivers aged under 30 years were most likely to use cannabis'.

2016 Radio 5 Live obtained figures from 35 of the 43 police forces in England on arrests for drug driving last year (March 2015 when new laws came in – April 2016). There were almost 8000 arrests. The Metropolitan Police made most arrests – 1636, Greater Manchester Police 5773 and Cheshire 561. South Yorkshire Police drug driving-related arrests went from 13 in the year until the test was

introduced to 456 the following year - a 3,400% increase, according to a BBC Yorkshire Freedom of Information (FOI) request.

2016 AAA (American Automobile Association) looked into road deaths in Washington State where recreational use of marijuana is now legal. The number of fatal road crashes has more than doubled since legalisation of cannabis in 2012. In 2014, the number of people killed in crashes where the driver had recently taken pot rose from 50 to 115. Over the same period the number of road deaths rose from 438 to 462. An estimated 1 in 6 fatal crashes in Washington involved a driver who had recently used pot. Several states allow a driver to get behind the wheel if they are below a pre-set cannabis limit.

2017 Wettlaufer et al estimated the harms and costs of cannabis-attributable collisions in the Canadian provinces. Cannabis-attributable traffic collisions caused 75 deaths, 4407 injuries, and 24,879 people involved in property damage only collisions in Canada in 2012. This cost \$1,094,972,062. costs being higher amongst younger people (16-34).

2017 Chihuri et al looked at the interaction of alcohol and marijuana on fatal road crash risk. 1944 drivers were fatally injured in the USA in 2006, 7, and 8. The results were: 'Overall, cases were significantly more likely than controls to test positive for marijuana (12.2% vs. 5.9%, $p < 0.0001$), alcohol (57.8% vs. 7.7%, $p < 0.0001$) and both marijuana and alcohol (8.9% vs. 0.8%, $p < 0.0001$). Compared to drivers testing negative for alcohol and marijuana, the adjusted odds ratios of fatal crash involvement were 16.33 [95% confidence interval (CI): 14.23, 18.75] for those testing positive for alcohol and negative for marijuana, 1.54 (95% CI: 1.16, 2.03) for those testing positive for marijuana and negative for alcohol, and 25.09 (95% CI: 17.97, 35.03) for those testing positive for both alcohol and marijuana'. They concluded that: 'Alcohol use and marijuana use are each associated with significantly increased risks of fatal crash involvement. When alcohol and marijuana are used together, there exists a positive synergistic effect on fatal crash risk on the additive scale'.

2017 Busardo et al looked at neurocognitive correlates in driving under the influence of cannabis. 'Delta (9)-tetrahydrocannabinol is the main psychoactive compound in cannabis and is commonly identified in blood samples from arrested drivers assumed to drive under the influence of drugs. Changing social norms towards cannabis and higher acceptability towards the drug emphasize the need for comprehensive understanding of the severe neurocognitive and psychomotor effects caused by cannabis and how these effects are correlated to driving skills and performance. In this review, PubMed, Cochrane Central, Scopus, Web of Science, Science Direct and EMBASE databases were used to identify and select publications up to January 2017 dealing with acute and chronic neurocognitive effects induced by cannabis and ability to drive. Thirty-six publications were selected for this review. The studies conducted were experimental, using simulators or on-road studies and brain imaging (structural and functional) to better understand the acute and chronic effects on cognitive functions comprised in the short and long-term fitness to drive after cannabis consumption. In a case-crossover self-report study a significant odds ratio increase was found for driving-related injury after combined exposure to cannabis and alcohol compared to cannabis alone (OR of 10.9 and 5.8 respectively). Both experimental and epidemiological studies have revealed that THC affects negatively both, psychomotor skills and cognitive functions. Studies of the acute effects of cannabis on driving have shown that drivers under the influence of this substance are impaired. Indeed, driving under the influence of cannabis doubles or triples the risk of a crash. Specifically, cannabis use impairs critical-tracking tasks increases lane weaving, decreases reaction time, and divided attention'.

2017 Malhotra et al looked at the perceptions of NZ drivers on driving under the influence of drugs. 434 drivers completed an online questionnaire. Hallucinogens and opiates were rated as having the greatest driving impairment and cannabis the lowest in illegal drugs. For legal drugs, sedatives were rated highest and anti-nausea and antidepressants the lowest. Drug users rated higher impairment ratings than non-users. Deciding not to drive was, alcohol (73.6%) was greatest, cannabis 57% strong painkillers 42.5%, antidepressants 10.0%. Respondents showed a greater acceptance of driving with legal drugs (43.5) than illicit drugs (10.3%) .

2017 Minaker et al looked at driving among youth, alcohol and marijuana, and passengers in Canada. 'The 2014-2015 Canadian Student Tobacco, Alcohol and Drug Survey was administered to 24 650 students in provincially generalizable samples A total of 9.1% of grade 11-12 students reported ever driving after drinking, and 9.4% reported ever driving after using marijuana. Almost half (48%) of grade 11-12 students reported ever participating in any risky driving or passenger behaviour. Over one-

third (35%) of grade 9-12 students reported ever riding with a driver who had been drinking, and 20% reported ever riding with a driver who had been using marijuana. Boys had higher odds of risky driving behaviours relative to girls, whereas girls had higher odds of risky passenger behaviours relative to boys. Students from rural schools had higher odds of drinking and driving and of riding with a driver who had drunk relative to students from urban schools. There were significant differences in risky driving and passenger behaviours by province.

2017 Li et al assessed individual and joint effects of alcohol and marijuana on the initiation of fatal two-vehicle crashes. Data on 14,742 culpable drivers (initiators) and 14,742 non-culpable drivers (non-initiators) involved in the same two-vehicle crashes between 1993 and 2014 were obtained from The Fatality Analysis Reporting System. Initiators were significantly more likely than non-initiators to test positive for alcohol (28.3% v 9.6%), marijuana (10.4% v 6.0%), and both substances (4.4% v 1.1%). Relative to those testing negative for both, the OR (Odds Ratio) of fatal crash initiation was 5.37, for those testing positive for alcohol and negative for marijuana 1.62, and for those testing positive for marijuana and negative for alcohol 6.93.

2017 Bonar et al looked at the prevalence and motives for drugged driving among emerging adults presenting to an emergency department. Abstract Emerging adults (N=586) ages 18-25 years (54% male, 56% African American, 34% European American) seeking care in an urban emergency department completed past-year surveys of demographics, frequency of DD within 4h of substance use, reasons for DD, and substance use. DD was reported by 24% of participants (with 25% of those engaging in high frequency DD). DD after cannabis use was most common (96%), followed by prescription opioids, sedatives, and stimulants (9%-19%). Common reasons for DD were: needing to go home (67%), not thinking drugs affected driving ability (44%), not having to drive far (33%), and not feeling high (32%). Demographics were not associated with DD, but, as expected, those with DD had riskier substance use. In this clinical sample, using a conservative measure, DD, particularly following cannabis use, was relatively common among emerging adults.

2017 Arterberry et al looked at empirical profiles of alcohol and marijuana use, drugged driving, and risk perceptions. 'Latent profile analysis of survey responses from 897 college students were used to identify patterns of substance use and drugged driving. We tested the hypotheses that low perceived danger and low perceived likelihood of negative consequences of drugged driving would identify individuals with higher-risk patterns. Findings from the latent profile analysis indicated that a four-profile model provided the best model fit. Low-level engagers had low rates of substance use and drugged driving. Alcohol-centric engagers had higher rates of alcohol use but low rates of marijuana/simultaneous use and low rates of driving after substance use. Concurrent engagers had higher rates of marijuana and alcohol use, simultaneous use, and related driving behaviors, but marijuana-centric/simultaneous engagers had the highest rates of marijuana use, co-use, and related driving behaviors. Those with higher perceived danger of driving while high were more likely to be in the low-level, alcohol-centric, or concurrent engagers' profiles; individuals with higher perceived likelihood of consequences of driving while high were more likely to be in the low-level engagers group. Findings suggested that college students' perceived dangerousness of driving after using marijuana had greater influence on drugged driving behaviors than alcohol-related driving risk perceptions'.

2017 Valen et al investigated the increase in cannabis use among arrested drivers in Norway. A time series observational study of cannabis use among all drivers tested for drugs during 2000-2015 was performed. Descriptive analyses of trends in frequencies and combined use of cannabis with other drugs or alcohol for different age groups and gender were conducted. Tetrahydrocannabinol (THC) is the main psychoactive substance in cannabis and was detected in blood samples from 18,767 suspected drug-impaired drivers. The annual number of THC findings increased during the years 2000-2015 for all age groups. For cannabis-only users, young drivers aged 20-29 years dominated during the whole period, whereas for multidrug-cannabis users the median age increased steadily during 2000-2015. After 2009, the annual increase in THC findings escalated; THC-only findings increased the most'.

2018 GHSA (Governors Highway Safety Association (US) Report Finds 'Drugged Driving' Becoming a Bigger Problem. A new report finds that "drugged driving" is becoming a more pervasive problem on American's roadways, with 44 percent of fatally-injured drivers with known results testing positive for drugs in 2016, up from 28 percent just 10 years prior. On top of that, more than half of those "drugged drivers" had marijuana, opioids, or a combination of the two in their system. Funded by the Foundation for Advancing Alcohol Responsibility, this new report – entitled *Drug-Impaired Driving: Marijuana and Opioids Raise Critical Issues for States* – found that among drug-positive fatally-injured drivers in

2016, 38 percent tested positive for some form of marijuana, 16 percent tested positive for opioids, and 4 percent tested positive for both marijuana and opioids.

2018 Steinemann et al looked at motor vehicle crash fatalities and under-compensated care associated with legalisation of marijuana. Abstract: Half of U.S. states have legalized medical cannabis (marijuana), some allow recreational use. The economic and public health effects of these policies are still being evaluated. We hypothesized that cannabis legalization was associated with an increase in the proportion of motor vehicle crash fatalities involving cannabis-positive drivers, and that cannabis use is associated with high-risk behavior and poor insurance status. Hawaii legalized cannabis in 2000. Fatality Analysis Reporting System (FARS) data were analyzed before (1993-2000) and after (2001-2015) legalization. Presence of cannabis (THC), methamphetamine, and alcohol in fatally injured drivers were compared. Data from the state's highest level trauma center were reviewed for THC status from 1997-2013. State Trauma Registry data from 2011-2015 were reviewed to evaluate association between cannabis, helmet/seatbelt use, and payor mix. THC-positivity among driver fatalities increased since legalization, with a three-fold increase from 1993-2000 to 2001-2015. Methamphetamine, which has remained illegal, and alcohol positivity were not significantly different before versus after 2000. THC-positive fatalities were younger, and more likely single-vehicle accidents, nighttime crashes, and speeding. They were less likely to have used a seatbelt or helmet. THC-positivity among all injured patients tested at our highest level trauma center increased from 11% before to 20% after legalization. From 2011-2015, THC-positive patients were significantly less likely to wear a seatbelt or helmet (33% vs 56%). They were twice as likely to have Medicaid insurance (28% vs 14%). Since legalization of cannabis, THC-positivity among MVC fatalities has tripled statewide, and THC-positivity among patients presenting to the highest level trauma center has doubled. THC-positive patients are less likely to use protective devices and more likely to rely on publically funded medical insurance. These findings have implications nationally and underscore the need for further research and policy development to address the public health effects and the costs of cannabis-related trauma.

2018 Greene investigated perceptions of driving after marijuana use compared to alcohol use among rural American young adults. ABSTRACT: Substance use contributes to motor vehicle crashes, the leading cause of death among young adults. The current qualitative study examined perceptions of the acceptability and harms associated with driving after marijuana versus alcohol use in rural America. Illuminating rural perspectives is critical given that the motor vehicle fatality rate is twice as high in rural as in urban areas in the USA. In 2015-2016, 72 young adults aged 18-25 years (Mage = 20.2; 50.7% female) living in Montana, USA, participated in 11 focus groups. A list of descriptive codes was generated inductively and two individuals coded participant comments. Discussion, memoing and concept mapping were used to uncover broader themes and transcripts were reviewed for evidence of these themes. There was shared consensus that, with regard to crash risk, driving after marijuana use was safer than driving after alcohol use. While alcohol was thought to impair driving ability universally, marijuana's impacts depended on individual characteristics (e.g. compensatory behaviours) and the marijuana itself (e.g. type). Participants expressed conflicting beliefs about policies surrounding marijuana use and driving but were more knowledgeable about alcohol-related policies. Participants viewed older adults and those in frontier areas as more disapproving of driving after marijuana use. Misinformation about the consequences of driving after marijuana use is common, demonstrating the need for future research and educational interventions. Developing and disseminating guidelines for driving after marijuana use would help marijuana users make informed decisions and mitigate driving-related risks.

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