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The incidence of drugs in drivers killed in Australian road traffic crashes

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Abstract

The incidence of alcohol and drugs in fatally injured drivers were determined in three Australian states; Victoria (VIC), New South Wales (NSW) and Western Australia (WA) for the period of 1990–1999. A total of 3398 driver fatalities were investigated which included 2609 car drivers, 650 motorcyclists and 139 truck drivers. Alcohol at or over 0.05 g/100 ml (%) was present in 29.1% of all drivers. The highest prevalence was in car drivers (30.3%) and the lowest in truckers (8.6%). WA had the highest rate of alcohol presence of the three states (35.8%). Almost 10% of the cases involved both alcohol and drugs. Drugs (other than alcohol) were present in 26.7% of cases and psychotropic drugs in 23.5%. These drugs comprised cannabis (13.5%), opioids (4.9%), stimulants (4.1%), benzodiazepines (4.1%) and other psychotropic drugs (2.7%). 8.5% of all drivers tested positive for Δ^9-tetrahydrocannabinol (THC) and the balance of cannabis positive drivers were positive to only the 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid (carboxy-THC) metabolite. The range of THC blood concentrations in drivers was 0.1–228 ng/ml, with a median of 9 ng/ml. Opioids consisted mainly of morphine ($n = 84$), codeine ($n = 89$) and methadone ($n = 33$), while stimulants consisted mainly of methamphetamine ($n = 51$), MDMA ($n = 6$), cocaine ($n = 5$), and the ephedrines ($n = 61$). The prevalence of drugs increased over the decade, particularly cannabis and opioids, while alcohol decreased. Cannabis had a larger prevalence in motorcyclists (22.2%), whereas stimulants had a much larger presence in truckers (23%).

Keywords: Drugs; Alcohol; Driving; Australia; Forensic toxicology

1. Introduction

There is increasing interest throughout the world concerning the incidence of drugs in driving and in their contribution to road trauma specifically. The most common drugs (other than alcohol) found in fatally injured drivers have been cannabis, benzodiazepines, amphetamine-like stimulants and opioids. A number of reports have detailed the incidence of drugs in fatally injured drivers around the world [1–14]. A number of jurisdictions have reported increase in the proportion of drivers using drugs [15–18]. Preliminary data has also suggested similar trends in Australia [19,20].

Injured drivers also show a high prevalence of drugs. Cannabinoids were found in 13.9% of French injured drivers, while opioids, cocaine and amphetamines were found in 10.5, 1.0 and 1.4%, respectively [21]. Impairing drugs were found in 32% of injured drivers presented to an urban emergency center in Colorado in which cannabis was the most frequent detected drug (17%), followed by alcohol (14%) [22]. In a South Australian study on injured drivers, cannabis was found in 10.8%, benzodiazepines in 2.7% and stimulants in 1.0% [23].

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There are significant variations in the type and frequency of detected drugs between jurisdictions. In New York, 20% of drivers killed in traffic crashes were positive to cocaine amongst drivers in the 16–45-year group [24]. A high incidence of cocaine use in impaired drivers was also observed in The Netherlands (33%). Benzodiazepines (33%) and opioids (19%) were also commonly seen [25]. In France, cannabinoids (13.9%) and opioids (10.5%) were most frequently drugs in drivers admitted to hospital as a result of their injuries [26]. Cocaine (1.0%) and amphetamines (1.4%) were infrequently detected. In contrast, Norwegian drugged drivers show a high incidence of benzodiazepines use of about 31% followed by THC (30%) and amphetamine (28%) [27]. In Scotland, benzodiazepines tend to be even more dominant with over 85% of fatally injured drivers testing positive to benzodiazepines [17].

The most controversial aspect of the involvement of drugs in accident causation is that of cannabis. Previous reports of Australian drivers have relied on coroners' records in which forensic laboratories only measured the inactive form of cannabis (carboxy-Δ^9-THC). Following the use of cannabis, this species is present in blood for up to several days and therefore its presence cannot be used to imply recent use of cannabis, and therefore likely impairment. Since 1998, the Australian forensic laboratories used in the study have measured THC routinely in fatal road crashes.

Australia is a modern community with a large and evolved network of roads in both urban and rural settings, and with a long history of a focus on road safety. The national legal limit for blood alcohol concentration (BAC) is 0.05%. The blood alcohol limit for commercial drivers and non-full license holders is zero. The population of Australia approaches 20 million and the states of Victoria (VIC), New South Wales (NSW) and Western Australia (WA) represent some 69% of Australian drivers.

The purpose of this study was to establish the incidence and extent to which drugs contributed to fatal motor vehicle accidents. This study presents the results of a 10-year research project involving a number of collaborating centers over three Australian states. In total 3398 drivers were included in this study. Due to the large amount of data, the results of the culpability analyses of alcohol and the various drug types have been described elsewhere [28].

2. Materials and methods

2.1. Study population

The study population consisted of drivers killed in motor vehicle accidents in the three Australian states of VIC, NSW and WA. In VIC these data were obtained from records kept at the Victorian Institute of Forensic Medicine and the State Coroner's Office at Southbank. Drivers were identified on the basis of records obtained from the Victorian Institute of Forensic Medicine. These cases included Victorian drivers killed in road crashes from 1990 to 1999.

In NSW, Coroner's case numbers and names of persons killed in motor vehicle accidents between January 1991 and March 1993, and from 1995 to 1999 were obtained from records kept at the Coroners' Courts in Glebe and at Westmead, Sydney. Drivers were identified on the basis of records obtained from the State Coroner's Office and included regional cases, except for cases accessed in 1995 and 1996 which only included the wider Sydney district.

In WA, information on drivers killed in motor vehicle crashes between 1990 and 1992 and from 1995 to end of 1999 was obtained from records kept at the Perth Coroner's Office. Drivers were identified on the basis of records obtained from the toxicology section of the Chemistry Centre. These cases included all Western Australian drivers killed in road crashes in these periods. Ethics permission to conduct these WA studies was obtained from the Perth Coroners Office.

2.2. Drug analysis

Most analyses (>90%) were conducted on blood taken at autopsy. In the remainder of cases blood specimens were taken in hospital prior to the death of the victim. In all three states toxicology testing on these deaths was similar and included testing for alcohol, drugs of abuse (amphetamines and related stimulants, benzodiazepines, cannabinoids, cocaine, opioids) and included a screen for neutral and basic psychotropic drugs. Other than confirmation of THC, there was no change in the overall pattern or extent of drug testing over this period of time.

All drugs detected were confirmed and quantified by appropriate techniques. Cannabis testing was based on the presence of Δ^9-tetrahydrocannabinol (THC) and/or the metabolite 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid (carboxy-THC). Since circa 1998 all three state laboratories conducted routine confirmations of cannabinoid presence by measurement of THC. Prior to this period, with the exception of NSW, not all cannabinoids detections were confirmed for THC, rather the metabolite carboxy-THC. The detection and confirmation limits for target drugs were comparable between the laboratories.

All the Australian laboratories took part in proficiency trials during this period, and all have been accredited by the national accreditation body in Australia (National Accreditation Testing Authority, NATA) in Forensic Science (toxicology). BAC was expressed as grams alcohol per 100 ml blood (%).

Drugs administered to the deceased as part of medical treatment were not included in the analysis. In most cases involving hospitalization, cases were excluded from the study since often toxicology testing had either not been conducted at all, or was not conducted on relevant antemortem specimens.

Table 1
Breakdown of case type by state

Parameter	VIC	WA	NSW	All states
No. of cases	1611	757	1030	3398
Alcohol and drug negative	839	530	335	1704
Alcohol positive (<0.05%)	53	31	41	125
Alcohol positive (≥0.05%)	422	271	297	990
Drug positive	454	245	208	907
Car drivers	1264	557	788	2609
Motor cyclists	314	164	172	650
Truckers	33	36	70	139
Single vehicle crashes	782	417	523	1722
Multiple crashes	829	340	507	1676

2.3. Categorization of drugs

To simplify the statistical analysis of drug-effects, drugs were categorized into drug families. All substances acting as stimulants were placed into the ''amphetamine'' group. This included amphetamine, methamphetamine, methylenedioxymethamphetamine, ephedrine, pseudoephedrine, phentermine and cocaine. Benzodiazepine drugs were placed into a single group. The ''opioid'' group included morphine, 6-acetylmorphine, codeine, methadone, propoxyphene and meperidine (pethidine). The cannabinoid group included cases found to contain either THC or carboxy-THC. All other impairing drugs were placed into the ''other'' drug group. This included sedating antihistamines, phenothiazine antipsychotics, tricyclic antidepressants, the anticonvulsants phenytoin and carbamazepine. Any non-impairing drug was placed into the ''miscellaneous'' group. This included acetaminophen, salicylate, quinine, theophylline, serotonin reuptake inhibitors etc.

Those cases classified as having died from natural causes or as a result of suicide, were excluded from the analysis. Cases were also excluded if there were long delays (>4 h) from the crash to their death or a relevant specimen was not obtained in hospital within this time frame.

3. Results

3.1. Characteristics of drivers

The total number of drivers included in the study was 3398. On average this represented over 85% of all drivers killed in this period. This included Victorian drivers (47.4% of study population), NSW (30.3%) and WA (22.3%). The breakdown of crash types (single and multiple vehicle crashes) and type of vehicle is shown in Table 1. Car drivers, motorcyclists and truckers represented 76.7, 19.1, and 4.1% of the study group, respectively. Single vehicle crashes represented 50.7% of the cases.

The gender distribution varied with vehicle type. The proportion of female car drivers, motorcyclists and truckers was 26.8, 2.0 and 0.7%, respectively. The proportion of females killed was highest in the >60 years age group (29.5%). The corresponding mean age and age range (in parentheses) in these three vehicle types was 38.5 (13–92), 28.8 (12–79) and 37.7 (17–68) years. Truckers were represented most in the 31–40 age group, while the highest proportion of motorcyclists killed were in the 22–30 years age group (Table 2).

Table 2
Breakdown of drivers by age, gender and driver type

Age range (years)	Number	Proportion by age bracket (%)				
		Male	Female	Trucker	Motor cyclist	Car driver
<18	109	83.5	16.5	0.9	35.8	63.3
19–21	598	82.1	17.9	0.7	20.9	78.4
22–30	973	83.0	17.0	3.7	28.0	68.3
31–40	620	78.9	21.1	6.8	21.1	72.1
41–50	395	74.7	25.3	9.1	13.9	77.0
51–60	259	76.1	23.9	6.2	7.3	86.5
>60	444	70.5	29.5	0.9	2.2	96.9
All ages	3398	79.0	21.0	4.1	19.1	76.8

Table 3
Prevalence of alcohol and drugs in all drivers and by crash type

Drug group	All drivers ($n = 3398$)		Single vehicle crashes ($n = 1722$)		Multiple vehicle crashes ($n = 1676$)	
	Number	Total driver population (%)	Number	Total driver population (%)	Number	Total driver population (%)
Drug and alcohol negative	1704	50.1	658	38.2	1046	62.4
Alcohol positive <0.05 g/100 ml	125	3.7	65	3.8	60	3.6
Alcohol positive ≥0.05 g/100 ml	990	29.1	760	44.1	230	13.7
Drug and alcohol positive	328	9.6	234	13.6	94	5.6
All drugs	907	26.7	482	28.0	425	25.4
All impairing drugs	800	23.5	438	25.4	362	21.6
Cannabis	460	13.5	273	15.9	187	11.1
Opioids	167	4.9	70	4.1	97	5.8
Stimulants	138	4.1	69	4.0	69	4.1
Benzodiazepines	138	4.1	70	4.1	68	4.1
Other impairing drugs	93	2.7	45	2.6	48	2.9
Non impairing drugs	211	6.2	87	5.1	124	7.4

3.2. Prevalence of alcohol

The prevalence of alcohol in all driver groups at ≥0.05% was 29.1% (Table 3) with a median BAC of 0.17%. The highest prevalence was in car drivers (30.3%), followed closely by motorcyclists (28.9%) and with only 8.6% of truckers positive to alcohol at or over the legal limit (Table 4). A further 3.2–5.2% of drivers were below 0.05%. 2.1% of drivers had a BAC of 0.05–0.079%, and 3.4% had a BAC of 0.08–0.099%. 2.9% of truckers, 10.5% of motorcyclists and 9.8% of drivers contained both alcohol and a drug.

WA had the highest prevalence of alcohol 0.05% in drivers (35.8%), and VIC the lowest (26.2%), whilst NSW drivers had an incidence of 28.8% (Fig. 1). Females were less likely to use alcohol than males (19.2% versus 36.4%).

For automobile drivers and truckers the highest proportion of alcohol positive drivers occurred in the 22–30 age group (46.8 and 16.7%, respectively). In motorcyclists the highest proportion occurred in the 31–40 age group (42.7%).

3.3. Prevalence of drugs

For the whole data set impairing drugs (other than alcohol) were present in 23.5% of drivers. This was made up of cannabinoids (13.5% of drivers), opioids (4.9%), stimulants and benzodiazepines (each 4.1%) (Table 3). The incidence of miscellaneous impairing drugs was 2.7%. The majority of all drug-positive cases involved more than one impairing

Table 4
Prevalence of alcohol and drugs in drivers by type

Drug group	Car driver		Motor cyclist		Trucker	
	Number	Total driver population (%)	Number	Total rider population (%)	Number	Total trucker population (%)
Drug and alcohol negative	1316	50.4	302	46.5	87	62.6
Alcohol positive <0.05%	84	3.2	34	5.2	7	5.0
Alcohol positive ≥0.05%	790	30.3	188	28.9	12	8.6
Drug and alcohol positive	256	9.8	68	10.5	4	2.9
All drugs[a]	676	25.9	194	29.9	37	26.6
All impairing drugs	582	22.3	182	28.0	36	23.5
Cannabis	307	11.8	144	22.2	9	6.5
Opioids	139	5.3	27	4.2	1	0.7
Stimulants	88	3.4	18	2.8	32	23.0
Benzodiazepines	126	4.8	11	1.7	1	0.7
Other impairing drugs	84	3.2	8	1.2	1	0.7
Non-impairing drugs	19	0.7	23	3.5	3	2.2

[a] All impairing drugs plus non-impairing drugs.

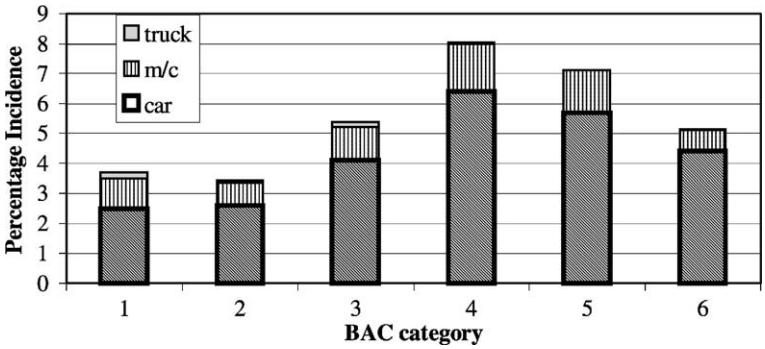

Fig. 1. Incidences of alcohol in car, truck and motor cycle drivers by blood alcohol category (1: 0.010–0.049%, 2: 0.050–0.099%, 3: 0.100–0.149%, 4: 0.150–0.199%, 5: 0.200–0.249%, 6: ≥0.250%).

substance. The largest group was combinations with alcohol (9.3%). Other combinations included cannabis with opioids (1.1%), amphetamines (0.8%) and benzodiazepines (0.7%), and amphetamine combinations with opioids (0.05%) and benzodiazepines (0.03%). Benzodiazepines with opioids represented 0.7% of the driving cohort. 0.7% of cases involved three or more impairing drugs.

Table 3 also shows the prevalences of alcohol and drugs in the single and multiple vehicle crashes. The incidences of chemical substances were higher in single vehicle crashes for alcohol (44.1% versus 13.7%) and cannabis (15.9% versus 11.1%). On the other hand, opioids (5.8% versus 4.1%) and miscellaneous drugs (7.4% versus 5.1%) were more frequently detected in multiple vehicle crashes. There was no appreciable difference in the two crash types for stimulants and benzodiazepines.

The incidence of THC in driver fatalities for the years it was tested in cases was 8.5%. This included 58 cases of THC-only (no other drugs or alcohol detected), 43 cases with alcohol and 20 cases with other impairing drugs. The range of THC concentrations detected in blood in all positive cases was 0.1–228 ng/ml (Table 5). The median blood concentration was 10 ng/ml in the THC-only group, 9 ng/ml in the THC plus alcohol group and 6 ng/ml in the THC plus other drugs group. In the THC-only group ($n = 58$ cases), 49 drivers (3.4%) were 5 ng/ml or higher. These included three females, one trucker, 13 motorcyclists and 35 car drivers.

The most common stimulants were pseudoephedrine/ephedrine ($n = 61$), methamphetamine ($n = 51$), MDMA ($n = 6$), and phentermine ($n = 12$) (Table 5). Cocaine or the metabolite benzoylecgonine was detected in five drivers (4 cars, 1 motor cyclists, all male). It was of interest that stimulants were present in 23% of all truckers. The most common opioids were morphine ($n = 84$), codeine ($n = 89$) and methadone ($n = 33$), while the most common benzodiazepines were diazepam ($n = 75$), temazepam ($n = 27$) and oxazepam ($n = 28$). A number of cases for each major

Table 5
Prevalence of alcohol and drugs in drivers by year

Drug group	1990–1993		1994–1996		1997–1999	
	Number ($n = 1057$)	Total driver population (%)	Number ($n = 921$)	Total driver population (%)	Number ($n = 1420$)	Total driver population (%)
Drug and alcohol negative	538	50.9	475	51.6	691	48.7
Alcohol positive <0.05%	35	3.3	38	4.1	52	3.7
Alcohol positive ≥0.05%	349	33.0	248	26.9	393	27.7
Drug and alcohol positive	95	9.0	82	8.9	139	9.8
All drugs[a]	235	22.2	245	26.6	427	30.1
All impairing drugs	211	20.0	210	22.8	379	26.7
Cannabis	115	10.9	124	13.5	221	15.6
Opioids	36	3.4	38	4.1	93	6.6
Stimulants	38	3.6	32	3.5	68	4.8
Benzodiazepines	36	3.4	35	3.8	67	4.7
Other impairing drugs	22	2.1	28	3.0	43	3.0
Non-impairing drugs	41	3.9	69	7.5	100	7.0

[a] All impairing drugs plus non-impairing drugs.

Table 6
Prevalences and blood concentrations of selected drugs and drug combinations

Drug	*N*	Mean (mg/l)	Median (mg/l)	Concentration range (mg/l)
THC-alone	58	0.012	0.010	0.0007–0.100
THC (+ other drugs)	20	0.022	0.006	0.0001–0.180
THC (+ alcohol)	43	0.017	0.009	0.001–0.228
Methamphetamine[a]	51	0.39	0.20	0.01–3.6
MDMA[a]	6	0.26	0.12	0.05–0.38
Ephedrines	61	1.0	0.40	0.01–11.5
Diazepam	75	0.46	0.20	0.03–7.5
Temazepam	27	0.75	0.20	0.03–5.7
Oxazepam	28	0.79	0.50	0.1–4.0
Flunitrazepam	11	0.06	0.05	0.01–0.15
Morphine	84	0.41	0.30	0.01–2.8
Codeine	89	0.40	0.30	0.01–7.4
Methadone[a]	33	0.56	0.50	0.01–2.3

[a] These drugs may have elevated concentrations due to postmortem redistribution.

drug exceeded the upper limit of concentrations normally associated with therapeutic use (Table 6).

The prevalence of cannabis was highest in the 22–30 age group for both motor cyclists (26.8%), and drivers of automobiles (19.7%). The prevalences in the over 50 age groups were zero and 0.3%, respectively. Stimulants were present in the greatest proportion in the 22–30 age group of truckers (44.4%), but only 5.4% in the corresponding age group of automobile drivers.

3.4. Prevalence of alcohol and drugs by year

The data was grouped into 3-year blocks to establish if any trends in the prevalence of alcohol and drugs occurred in the 10-year period (Table 6). The prevalence of alcohol dropped from 33.0 in 1990–1993 to just under or just over 27% in the following 6 years to 1999. In contrast, the prevalence of drugs increased in all 3-year blocks. For impairing drugs the increase was from 20.0% (1990–1993) to 26.7% (1997–1999). This increase was most marked for cannabis (10.9–15.6%) and for opioids (3.4–6.6%). However, smaller increases occurred for all other key drug groups (Table 6). The overall proportion of drug-free drivers involved in fatalities dropped steadily from 50.9% (1990–1993) to 48.7% (1997–1999).

4. Discussion

This 10-year multi-center study of drug-involved driving has shown a substantial incidence of drugs other than alcohol. In the last 3 years, over one-quarter of all drivers had used an impairing drug, an overall increase of 6.7% compared to the 1990–1993. The increasing prevalence of drug presence in fatally injured drivers was associated with a decline in the involvement of alcohol. Overall, the proportion of drivers with a BAC of 0.05% or higher fell over 8% between 1990 and 1999, and was similar in prevalence to drug-positive drivers in 1999. It was of interest that few drivers were positive to alcohol below 0.05% (3.7% of drivers), and even fewer between 0.05 and 0.079% (2.1%). This is because most drivers had a BAC over 0.10% (25.7% of all drivers).

The prevalence of drugs in Australian fatal crashes is similar to previously published studies in other countries (Table 7). As in most countries, cannabis was the most frequently detected drug. Benzodiazepines, amphetamine-like stimulants and opioids represented the next class of frequently detected drugs. However, one notable difference is the absence of any significant presence of cocaine in fatally injured drivers in Australia. This is not unexpected since relatively few coroners' cases involve cocaine due to its relative scarcity (OH Drummer, personal communication).

Stimulants generally represent a diverse group of drugs and make up a reasonable proportion of drug detected in fatally injured drivers. These include amphetamines and ecstasy (MDMA), cocaine as well as the ephedrines and the anorexiants (e.g. phentermine). The greatest use of these drugs was by longer-distance drivers (e.g. truckers). The finding that stimulants were detected in 23% of truckers is in accord with other studies showing a relatively high use of stimulants by this group [9,29].

The largest increase in drug detection was in the cannabinoids and opioid groups. In Australia, both drug types have shown an increasing prevalence. National household surveys show increases in current and lifetime use of many of these drugs, particularly cannabis and amphetamines [30]. The markedly rising heroin death toll in Victoria and other states attests to the rising prevalence of the use of opioids. This is reflected by the relatively high number of cases using heroin or morphine (often only detected as morphine in blood analyses), and the relatively high number of methadone cases. There is, however, no direct evidence that methadone

Table 7
Selected summaries of the incidence of drugs in fatally injured drivers

Reference	Number of cases	Location	Alcohol prevalence (%)	Drug prevalence (%)	Specific drugs
[1]	484 driver fatalities	Ontario, Canada (1978–1979)	57	26	Cannabis, 12%; THC, 3.0%; benzodiazepines, ~3.7%; opioids, 2.1%; cocaine, 0.2%; stimulants ~0.2%
[3]	600 single vehicle accidents	North Carolina, USA (1878–1881)	79	28	THC, 7.8%; methaqualone, 6.2%; barbiturates, 3/0%
[4]	440 male drivers, ages 15–34 years	California, USA	70	52	Cannabis, 37%; cocaine, 11%; other drugs, 26%
[5]	1518 driver fatalities	Alabama (1980–1984)	63	~22	Cannabis, ~17%; diazepam, 2.1%; methaqualone, 2.2%
[6]	597 driver fatalities	Düsseldorf, Germany	–	11.4	
[7]	1273 driver fatalities	England and Wales	–	7.4 (psychotropic)	Cannabis, 2.5%; diazepam, 1.4%
[24]	449 driver fatalities	New York (1984–1987)	47.4	–	Cocaine, 20%
[2]	1169 driver fatalities	Ontario, Canada (1982–1984)	57	>17	Cannabis, 17.2%; THC, 10.9% (0.2–37 ng/ml)
[8]	1882 driver fatalities	13 regions of USA	52	18	Cannabis, 6.7%; cocaine, 5.3%; tranquillisers, 2.9%; amphetamines, 1.9%
[10]	159 driver fatalities	Norway (1989–1990)	28.3	16.4	Cannabis, 5.0%; benzodiazepines, 6.3%
[9]	168 truck driver fatalities	Eight USA states	12.5	33 (with ethanol)	Cannabis, 13% (THC 70%); cocaine, 8.3%; stimulants, 18%
[12]	227 driver fatalities	British Columbia, Canada (1990–1991)	48	20	Cannabis, 13% (THC-COOH); cocaine, 4%; diazepam, 5%
[38]	Driver fatalities	Washington State, USA	~40	~15	Cannabis, 11%; cocaine, 3%; amphetamines, 2%
[13]	98 single vehicle driver fatalities	Victoria (1996), Australia	36 (>0.05)	36	Cannabis, 22%
[14]	285 driver fatalities	Spain (1994–1996)	50.5	10.2 (illegal drugs)	Cocaine, 7.4%; opioids, 4.9%; cannabis, 1.4%

itself causes motor vehicle crashes including those cases using diverted methadone [31,32].

THC was detected in 8.5% of cases in which it was measured. This represents a THC confirmation rate of about 52%, i.e. THC was detected in just over half of the cases in which carboxy-THC was identified. It is the THC-positive drivers who are likely to have recently used cannabis and to have been impaired at the time of the crash [33,34]. Analysis of these cases by responsibility analyses shows THC-positive drivers to have a statistically higher culpability rate than drug-free drivers [28].

It was of interest that cannabis was more frequently detected in single vehicle crashes than in multiple vehicle crashes (16% versus 11%). This was more true for alcohol in which the incidence was over double that of single vehicle crashes. The difference for other drugs was less dramatic, although opioids and miscellaneous drugs showed a slightly greater prevalence in multiple vehicle crashes.

The selection of cases is unlikely to have introduced significant bias as this was done by independent persons, the clerk of court or another official. However, the exclusion of many cases who survived for a time in hospital may have tended to exclude more young drivers. This may have resulted in a slight under-estimation of the prevalence of cannabis/THC and illicit drugs among fatally injured drivers. Any under-estimation is unlikely to have affected year-to-year or state-by-state comparisons.

In this study, 65% of opioid-positive drivers were using other drugs, predominantly benzodiazepines (34%) and cannabis (24%). The additional use of other impairing drugs is likely to have increased the drivers' impairment and the likelihood of significant driver errors compared with drivers who used only opioids.

For some drugs some increases in blood concentration may have occurred due to postmortem redistribution [35–37]. This applies particularly to methamphetamine and to

methadone, but other drugs are likely to have some alteration in concentration due to postmortem artifacts. However, even allowing for possible postmortem changes many of the cases had drugs detected at concentrations that reflected misuse of the drug.

The results of the present study strongly suggest the problem posed by drug-affected drivers is much greater than that suggested by the number of prosecutions for drug-impaired driving. Indeed, standard field sobriety tests or medical evaluations tend to only detect drivers with substantial clinical impairment. As responsibility analyses suggest impairing drug use contribute to road trauma, there is a need to recognize that recreational drugs are a likely significant cause of road trauma, and therefore there is a need to provide effective counter-measures to reduce the use of recreational drugs by drivers.

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