Driving Under the Influence of Cannabis

CCSA - CCLAT

Analysis drawn from the 2004 Canadian Addiction Survey

Authors: Douglas J. Beirness, Ph.D., Senior Research Associate, Canadian Centre on Substance Abuse; and Christopher G. Davis, Ph.D., Research and Policy Associate, Canadian Centre on Substance Abuse, and Associate Professor of Psychology, Carleton University

The Canadian Addiction Survey (CAS) was a collaborative initiative sponsored by Health Canada, the Canadian Centre on Substance Abuse (CCSA) and the Canadian Executive Council on Addictions (CECA)—which includes the Alberta Alcohol and Drug Abuse Commission (AADAC), the Addictions Foundation of Manitoba (AFM), the Centre for Addiction and Mental Health (CAMH), the Prince Edward Island Provincial Health Authority, and the Kaiser Foundation—the Centre for Addictions Research of BC (CAR-BC), and the provinces of Nova Scotia, New Brunswick and British Columbia. Analysis presented in this and similar reports is intended to supplement the original CAS detailed report.

Introduction

Following two decades of substantial decreases in the magnitude of the alcohol crash problem (Beirness et al., 1994; Mayhew et al., 2004), greater public and political attention is now being directed at the issue of driving under the influence of drugs. However, this issue has yet to elicit the level of concern that surrounds drinking and driving. Research on drugs and driving has lagged considerably behind research on alcohol and driving, and as a result, what we know and understand about the role of drugs in crashes pales in comparison to what we have learned about the involvement of alcohol. Nevertheless, concern about drugs and driving has increased dramatically and has become a recognized road safety issue of its own.

Among the many psychoactive substances that are known to adversely affect psychomotor and cognitive skills needed to operate a motor vehicle safely, cannabis has prompted the greatest public interest. To a great degree, this reflects the extent of its use, particularly among those in the early stages of their driving career. Added to this is the ongoing debate about de-criminalizing the possession of small amounts of cannabis and the fear that

liberalization of cannabis use policy will lead to increased use and more frequent driving under the influence.

Even in the absence of more lenient policy changes, the use of cannabis in Canada appears to be increasing. In the 1989 National Alcohol and Other Drugs Survey (NADS) (Eliany, Giesbrecht & Nelson, 1990), 6.5% of Canadians aged 15 and older reported using cannabis in the previous 12 months. Five years later, Canada's Alcohol and Other Drugs Survey (CADS) reported that 7.4% had used cannabis in the past year (McNeil & Webster, 1997). Most recently, in the 2004 Canadian Addiction Survey (CAS), 14.1% of Canadians reported using cannabis in the 12 months prior to the survey (Patton & Adlaf, 2005). In 15 years, cannabis use in Canada has more than doubled.

Driving after using cannabis has also increased. In 1988, 2.1% of respondents to Canada's National Survey on Drinking and Driving (Jonah, 1990; Simpson et al., 1992) indicated that they had driven after using cannabis. One year later, the NADS reported that 2.3% had driven after using cannabis. In Ontario, surveys by the Centre

for Addiction and Mental Health found the prevalence of driving under the influence of cannabis increased from 1.9% in 1996–97 to 2.7% in 2002 (Walsh & Mann, 1999; Centre for Addiction and Mental Health, 2003).

Among young people, the prevalence of driving after using cannabis is considerably higher. In both the National Survey on Drinking and Driving (1988) and the NADS (1989), driving after cannabis use was highest among those aged 18 to 24 (5.4% and 6.1%, respectively). In Ontario, in 1996–97, 9.3% of 18 to 19 year olds had driven after using cannabis (Walsh & Mann, 1999); in 2002, 19.3% of students in Grades 10 through 13 had done so (Adlaf, Mann & Paglia, 2003). In a recent survey of senior students in the Atlantic provinces, 15.1% reported driving after using cannabis (Asbridge, Poulin & Donato, 2005).

Concerns about the safety of driving under the influence of cannabis are reflected in numerous experimental studies examining the effects of the drug on psychomotor performance, and epidemiological studies that calculate collision risk. Several recent reviews of this literature are available (Beirness, Simpson & Williams, 2006; Jones, Shinar & Walsh, 2004; Mann, Brands, Macdonald & Stoduto, 2003).

Experimental studies have assessed the nature and extent of the effects of cannabis on a wide variety of cognitive and psychomotor tasks (e.g., Ashton 2001; Berghaus and Guo, 1995). Performance deficits have been found in tracking, reaction times, visual function, and divided attention. Studies of driving performance (both simulated and on-road) show increased variability in lateral position in the lane, headway gap, and speed as a function of cannabis use. Cannabis also impaired performance on divided attention tasks and compromised drivers' ability to handle unexpected events.

Although the weight of evidence clearly reveals significant psychomotor impairment as a result of cannabis use, it has been suggested that experienced users may be aware of their state of intoxication and impairment and may attempt to compensate for it by employing behavioural strategies such as slowing down, increasing headway, and reducing risk-taking behaviours (Smiley, 1986). These tactics, however, may not be sufficient to compensate for all the impairing effects of cannabis, particularly at higher doses.

In general, the effects of cannabis are stronger with higher doses of the drug, but clear dose-response relationships are not always evident. However, it is abundantly clear that combining cannabis with even small amounts of alcohol increases the extent of observed impairment.

Epidemiological studies that have attempted to determine the risk of crash involvement associated with driving after cannabis use have shown mixed results. Among the most methodologically rigorous studies, two show significant increases in risk (Drummer, Gerostamoulos, Batziris, et al., 2004; Mura, Kintz, Ludes, et al., 2003) and two failed to find a significant increase in risk (Longo, Hunter, Lokan et al., 2000; Williams, Peat, Crouch et al., 1985).

The purpose of this paper is to add to existing knowledge about driving under the influence of cannabis. Using data from the Canadian Addiction Survey, this paper provides contemporary evidence of the prevalence of driving after using cannabis in Canada and describes the characteristics of those who engage in the behaviour.

Errata   August 2007

This report includes analyses of scores on the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST), a six-item screener to measure problematic drug use. An error was recently found in one item of this screener. Properly stated, the question is "Have you ever tried [AND FAILED] to control, cut down or stop using cannabis, marijuana or hashish. The phrase "and failed" was not asked of respondents. This error should not affect estimates of subgroup differences (i.e., DUIC vs. non-DUIC drivers; see Table 3). However, caution and warning should be used in making direct comparisons with other studies using the ASSIST.

Method

The Canadian Addiction Survey (CAS) is a telephone survey conducted in late 2003 and early 2004 on behalf of the Canadian Centre on Substance Abuse and Health Canada (Adlaf, Begin & Sawka, 2005). The CAS is based on a two-stage (telephone household, respondent) random sample of 13,909 residents of Canada 15 years of age and older, stratified by 21 regional areas defined by Statistics Canada's Census Metropolitan Areas and also comprising non-CMA areas within each province. Weights have been applied based on 252 population classes, stratified by the 21 regional areas by six age groups and by sex to yield a sample that is representative of the Canadian population aged 15 and older. Variance estimates and confidence intervals reported have been adjusted for design effects. Detailed information on the sample and methods is published elsewhere (Adlaf & Rehm, 2005). The response rate was 47%.

Questions on driving after using cannabis were included in only one of three panels of the sample (N = 4,639). Respondents who reported using cannabis in the past year, possessed a valid licence, and reported driving a motor vehicle in the past year were asked how frequently they had driven within two hours of using cannabis (DUIC).

Results

To ensure that results from respondents in the panel asked about DUIC were representative of the larger population of cannabis users, the reported prevalence of cannabis use in this sub-sample was compared with that among the entire CAS sample. Table 1 shows reported cannabis use for the two groups in four time periods—the past 30 days, the past three months, the past 12 months, and lifetime use. Cannabis use was marginally higher among respondents in the sub-sample than that among the entire CAS sample in all four time periods. Among those in the sample asked about DUIC, 15.4% indicated they had used cannabis in the past year.

Overall, 176 respondents indicated that they had operated a vehicle within two hours of using cannabis at least once in the past 12 months. This represents 4.8% (3.7–6.2%) of the population of licensed drivers or 33.3% (26.6–40.9%) of the population of drivers who had used cannabis in the past year. Among those who reported DUIC, the mean number of self-reported occurrences was 24.5 (median = 10).

Table 1: Reported Cannabis Use Among Entire CAS Sample and Sub-Sample Asked About Driving After Using Cannabis

	Entire CAS Sample [95% CI]	Sub-Sample [95% CI]
Lifetime Use	44.5% [43.0–46.0]	45.5% [42.8–48.0]
Use Past 12 Months	14.1% [13.1–15.1]	15.4% [13.6–17.4]
Use Past 3 Months	11.1% [10.2–12.1]	12.2% [10.5–14.0]
Use Past 30 Days	8.8% [8.0–9.7]	9.4% [8.0–11.1]

Demographic characteristics

Table 2 compares the demographic characteristics of those who drove under the influence of cannabis to those of drivers who did not. DUIC drivers were more likely than non-DUIC drivers to be male. In fact, males were 3.6 times more likely than females to drive under the influence of cannabis. Overall, DUIC drivers were considerably younger than non-DUIC drivers. The average age of DUIC drivers was 28.7 years—almost 17 years younger than non-DUIC drivers. Those who reported driving under the influence of cannabis were also more likely to be single (i.e., never married) than non-DUIC drivers. DUIC drivers were more likely to reside in rural areas and to drive on a daily or almost daily basis than non-DUIC drivers.

Alcohol and drug use

Table 3 compares measures of cannabis and alcohol use among the two groups of drivers. It is evident that DUIC and non-DUIC drivers differed considerably in terms of the extent of their use of cannabis and alcohol. The DUIC group reported more frequent use of cannabis and showed a tendency to have started using cannabis at an earlier age than other cannabis users who did not drive under the influence of cannabis (p < .06). They were also more likely to report the use of other drugs (i.e., cocaine, hallucinogens, ecstasy, amphetamines and/or heroin).

The CAS included a measure of cannabis-related harm based on six questions about the frequency of use, health and social harms associated with cannabis use, and other indicators of problems from the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) developed by the World Health Organization (Henry-Edward et al., 2003). As shown in Table 3, the DUIC group scored significantly higher than the non-DUIC group on the ASSIST, suggesting a greater likelihood of problems associated with cannabis use among those who drive after using cannabis.

The DUIC group also reported heavier patterns of drinking than others. The DUIC groups reported having consumed a higher quantity of alcohol in the seven days prior to the survey and scored higher on the Alcohol Use Disorders Identification Test (AUDIT), an instrument developed by the World Health Organization to screen for drinking problems (Babor, Higgins-Biddle et al., 2001; Saunders, Aasland, Babor et al., 1993). Scores of eight or higher are conventionally used to identify people with hazardous and harmful drinking patterns that by definition cause damage to health or increase the likelihood of future mental and physical health problems. DUIC drivers scored significantly higher on the AUDIT than non-DUIC drivers. With a mean AUDIT score of 8.3, it is evident that a large proportion of DUIC drivers also experience problems associated with hazardous levels of alcohol consumption.

Table 2: Demographic Characteristics of DUIC Drivers and Non-DUIC Drivers

	DUIC Drivers [95% CI]	Non-DUIC Drivers [95% CI]	Test[1]	Significance
% Male	76.9% [65.7–85.3]	48.0% [45.1–51.0]	*OR = 3.61*	p < .001
Mean Age[2]	28.7 [26.5–30.9]	45.3 [44.2–46.3]	*F = 179.61*	p < .001
% Never Married	59.9% [46.6–71.8]	21.8% [19.4–24.3]	*OR = 5.36*	p < .001
% Rural Resident	19.7% [11.2–32.4]	8.4% [5.2–13.1]	*OR = 2.70*	p < .01
% Drive Daily	68.5% [53.6–80.3]	83.8% [81.5–85.8]	*OR = 0.37*	p < .01

[1] All tests (except the first) control for sex.
[2] There was also a marginally significant interaction of sex and DUIC status (F = 3.57, *p* < .06) indicating that women who drive under the influence of cannabis tend to be younger (M = 25.1, 95% CI: 23.1–28.7) than men who do so (M = 31.5, 95% CI: 28.1–34.9); no such age difference was observed for non-DUIC.

Table 3: Cannabis and Alcohol Use Among DUIC Drivers and Non-DUIC Drivers

|	DUIC Drivers [95% CI]	Non-DUIC Drivers [95% CI]	Test[1]	Significance
Days Cannabis Use (past month)	12.5 [9.9–15.1]	4.6[2] [2.6–6.5]	$F = 22.68$	$p < .001$
Age Started Using Cannabis	16.9 [15.5–18.3]	18.5[2] [17.5–19.5]	$F = 3.81$	$p < .06$
ASSIST	11.0 [9.3–12.7]	4.3[2] [3.5–5.1]	$F = 49.1$	$p < .001$
% Other Substance Use	29.0% [18.8–42.6]	1.4% [1.0–2.2]	$OR = 25.6$	$p < .001$
Number of Drinks (past 7 days)	8.8 [5.7–11.8]	2.7 [2.4–3.0]	$F = 14.7$	$p < .001$
AUDIT	8.3 [7.4–9.2]	3.5 [3.3–3.7]	$F = 98.6$	$p < .001$

[1] All tests control for sex.
[2] Contrast group for these analyses is those who have used cannabis during the past 12 months, but report not driving within 2 hours of using.

Given the reported drinking patterns of the DUIC group, it was reasonable to expect that they might also drive after drinking. Indeed, the DUIC group was considerably more likely than the non-DUIC group to drive after consuming alcohol. Whereas 36.1% of the DUIC group also reported driving after drinking, only 10.4% of the non-DUIC did so (OR = 4.89, 95% CI = 2.79–8.56).

Despite the apparent overlap between the two behaviours, there are notable similarities and differences in the characteristics of those who engage in each of these behaviours. For example, whereas those who drive after using cannabis and those who drive after drinking are predominantly male (> 75%) and more than half have

never been married, the DUIC group is less likely than the drinking-driving group to drive daily (68.5% and 92.6%, respectively).

Those who drive after using cannabis are also an average of 11 years younger than those who drive after drinking (mean age 28.7 and 39.8 years, respectively). This difference is further illustrated in Figure 1, which shows the percentage of drivers who report driving after using cannabis and driving after drinking separately for various age groups. It is apparent that younger drivers are more likely than older drivers to engage in these behaviours, but whereas the prevalence of driving after using cannabis diminishes progressively with age, driving after drinking remains relatively stable after age 24.

Figure 1: Age Distribution of Drivers After Drinking and Drivers After Using Cannabis
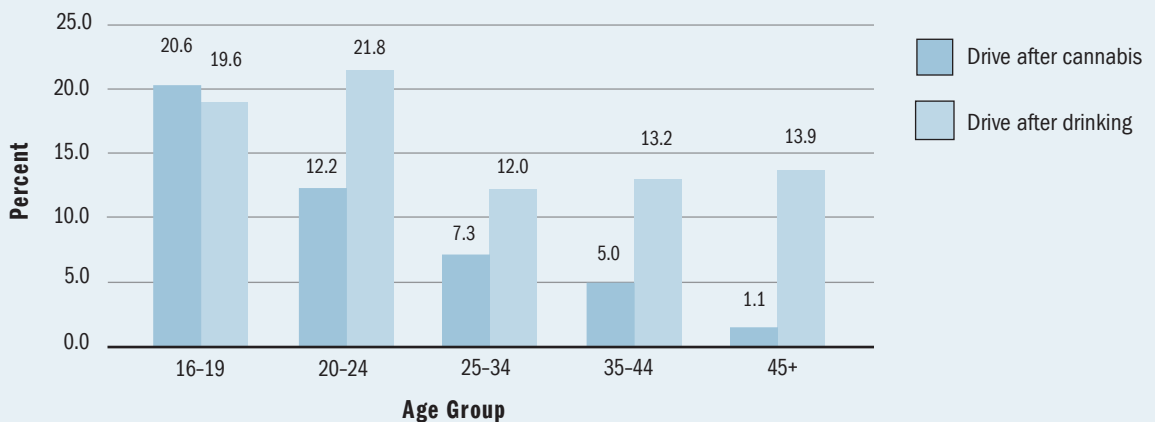
Conclusion

Increased public concern about the extent to which drivers on Canadian roads are under the influence of cannabis appears to coincide with reported increases in the prevalence of the behaviour. In the period between 1988 and 2004, the percentage of Canadian drivers who reported driving after using cannabis increased from 2.1% to 4.8%. Among young males, DUIC has reached levels that are comparable to, or exceed, those of driving after drinking.

The extent to which cannabis use by drivers contributes to serious road crashes is difficult to determine, largely because of the poor rates of testing for drugs other than alcohol among drivers involved. Nevertheless, it can be expected that as the prevalence of driving under the influence of cannabis increases, the number of resulting collisions will inevitably increase as well.

The increase in DUIC, particularly among young Canadians, may be attributable, in part, to the increased use of cannabis. Clearly, with more users—and more frequent use—the likelihood of driving after using cannabis rises proportionately. The fact that young cannabis users may not perceive their driving ability to be adversely affected—and/or perceive it to be less affected than after consuming alcohol—provides a false sense of security. In addition, many young people believe that it is difficult for the police to detect and charge drivers for DUIC. The lack of a strong, credible deterrent only reinforces such beliefs.

Although it is tempting to consider the possibility of simply adapting the same techniques, policies, procedures and countermeasures that were developed for the drinking and driving problem to deal with the drugs and driving issue, such an approach belies the complexity of the issue. Whereas there may be similarities and parallels between drinking and driving and drugs and driving, it is important to appreciate that the differences are substantial. For example, whereas alcohol is a legal substance, the use of which permeates many aspects of society, the possession of cannabis is illegal or at least restricted to those who use it for therapeutic purposes.

Although there is some overlap among those who drink and drive and those who drive under the influence of cannabis, it is clear that DUIC involves a considerably younger population. From an enforcement perspective, cannabis use, unlike alcohol, cannot be measured from breath samples, but requires more invasive, time-consuming and expensive procedures.

Therefore, although there is much to be learned from years of experience in the area of drinking and driving, societal attempts to control DUIC must recognize the substantial differences that exist and develop an innovative and comprehensive approach to deal specifically with this issue. Such an approach requires a combination of research, prevention, enforcement and rehabilitation. Research is needed to provide better estimates of the magnitude of the problem and greater understanding of the factors that give rise to the behaviour.

Awareness and education programs need to be developed for the general population and for specific high-risk groups, such as youth, to provide factual information and dispel common myths. Schools, driver licensing offices, and driver education programs are potential targets for the implementation of such prevention activities.

Enforcement efforts can be bolstered with more widespread use of the Drug Recognition Expert program. This program provides the police with an objective means of determining impairment caused by drugs, which, when combined with the analysis of a sample of bodily fluid, provides the basis for drug-impaired driving charges.

Assessment and rehabilitation programs also play a role in an overall strategy. For those convicted of drug-impaired driving, the extent of their drug use should be assessed and, where warranted, treatment and rehabilitation programs must be available to help ensure the behaviour does not recur or escalate. Together, these elements can be integrated into a comprehensive and effective response to the issue of driving under the influence of cannabis.

References

Adlaf, E., Mann, R.E., & Paglia, A. (2003). Drinking, cannabis use and driving among Ontario students. *Canadian Medical Association Journal* 168(5) 565–566.

Adlaf, E., & Paglia-Boak, A. (2006). Drug Use Among Ontario Students 1977–2005. CAMH Research Document Series No. 16. Toronto: Centre for Addiction and Mental Health.

Adlaf, E.M. (1993). Alcohol and Other Drug Use. In T. Stephens & D. Fowler Graham (Eds.), Canada's Health Promotion Survey 1990: Technical Report. (Catalogue No. H39-263/2-1990E). Ottawa: Health and Welfare Canada.

Adlaf, E.M., & Rehm, J. (2005). Survey Design and Methodology. In E.M. Adlaf, P. Begin, & E. Sawka (Eds.), Canadian Addiction Survey (CAS): A national survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: Detailed report, pp. 11–19. Ottawa: Canadian Centre on Substance Abuse.

Adlaf, E.M., Begin, P., & Sawka, E. (Eds.) (2005). Canadian Addiction Survey (CAS): A national survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: Detailed report. Ottawa: Canadian Centre on Substance Abuse.

Adlaf, E.M., Demers, A., & Glicksman, L. (Eds.) (2005). Canadian Campus Survey 2004. Toronto: Centre for Addiction and Mental Health.

Asbridge, M., Poulin, C., & Donato, A. (2005). Motor vehicle collision risk and driving under the influence of cannabis: Evidence from adolescents in Atlantic Canada. *Accident Analysis and Prevention* 37: 1025–1034.

Ashton, C.H. (2001). Pharmacology of cannabis: A brief review. *British Journal of Psychiatry* 178: 101-106.

Babor, T.R., Higgins-Biddle, J.C., Saunders, J.B., & Monteiro, M.G. (2001). The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care (2nd Edition). Geneva: World Health Organization.

Beirness, D.J., Simpson, H.M., & Williams, A.F. (2006). The role of cannabis and benzodiazepines in motor vehicle crashes. Transportation Research E-Circular, Number E-C096. Washington: Transportation Research Board of the National Academies.

Beirness, D.J., Simpson, H.M., Mayhew, D.R., & Wilson, R.J. (1994). Trends in drinking driver fatalities in Canada. *Canadian Journal of Public Health* 85: 19–22.

Berghaus, G. and Guo, B.L. (1995). Medicines and driver fitness—findings from a meta-analysis of experimental studies as basic information to patients, physicians, and experts. In C.N. Kloeden, and A.J. McLean (Eds.), Alcohol, Drugs and Traffic Safety—T'95: Proceedings of the 13th International Conference on Alcohol, Drugs and Traffic Safety, pp 295-300. Adelaide: ICADTS.

Centre for Addiction and Mental Health (2003). Cannabis Use and Driving among Ontario Adults. CAMH Population Studies eBulletin, May/June 2003, No. 20. Toronto, Ontario: CAMH.

Drummer, O.H., Gerostamoulos, J., Batziris, H., Chu, M., Caplehorn, J., Robertson, M.D., & Swann, P. (2004). The involvement of drugs in drivers of motor vehicles killed in Australian road traffic crashes. *Accident Analysis and Prevention*; 36(2): 239-248.

Eliany, M., Giesbrecht, N., & Nelson, M. (Eds.) (1990). National Alcohol and Other Drugs Survey: Highlights Report. Ottawa: Health and Welfare Canada.

Henry-Edwards, S., Humeniuk, R., Ali, R., & Poznyak, V. (2003). The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST): Guidelines for Use in Primary Care. Geneva: Obtained from *www.who.int/substance_abuse/activities/en/Draft_The_ASSIST_Guidelines.pdf*.

Jonah, B.A. (1990). Age differences in risky driving. *Health Education Research* 5(2): 139–149.

Jones, R.K., Shinar, D., & Walsh, J.M. (2003). State of Knowledge of Drug-Impaired Driving. DOT HS 809 642. Washington, DC: National Highway Traffic Safety Administration.

Kellner, F. (2005). In E.M. Adlaf, P. Begin, & E. Sawka (Eds.), Canadian Addiction Survey (CAS): A national survey of Canadians' use of alcohol and other drugs: Prevalence of use and related harms: Detailed report, pp. 33–47. Ottawa: Canadian Centre on Substance Abuse.

References (cont'd)

Longo, M.C., Hunter, C.E., Lokan, R.J., White, J.M., & White, M.A. (2000b). The prevalence of alcohol, cannabinoids, benzodiazepines and stimulants amongst injured drivers and their role in driver culpability—Part II: The relationship between drug prevalence and drug concentration, and driver culpability. *Accident Analysis and Prevention* 32(5): 623–632.

Mann, R.E., Brands, B., Macdonald, S., & Stoduto, G. (2003). Impacts of cannabis on driving: An analysis of current evidence with an emphasis on Canadian data. TP 14179 E. Ottawa: Road Safety and Motor Vehicle Regulation Directorate Transport Canada.

Mayhew, D.R., Beirness, D.J., & Simpson, H.M. (2000). Trends in drinking driving fatalities in Canada—progress continues. In Proceedings of the International Conference on Alcohol, Drugs and Traffic Safety, #703, Stockholm: Swedish Road Safety Institute.

Mayhew, D.R., Brown, S.W., & Simpson, H.M. (2004). The Alcohol-crash Problem in Canada: 2002. Ottawa: Transport Canada.

McNeil, P., & Webster, I. (1997). Canada's Alcohol and Other Drugs Survey 1994: A Discussion of the Findings (Vol. Cat.: H39-338/1-1995E). Ottawa: Minister of Public Works and Government Services Canada.

Mura, P., Kintz, P., Ludes, B., Gaulier, J.M., Marquet, P., Martin-Dupont, S., Vincent, F., Kaddour, A., Goullé, J.P., Nouveau, J., Moulsma, M., Tilhet-Coartet, S., & Pourrat, O. (2003). Comparison of the prevalence of alcohol, cannabis and other drugs between 900 injured drivers and 900 control subjects: Results of a French collaborative study. *Forensic Science International* 133: 79–85.

Patton, D., & Adlaf, E.M. (2005). Cannabis use and problems. In E.M. Adlaf, P. Begin and E. Sawka (Eds.), Canadian Addiction Survey (CAS): A National Survey of Canadians' Use of Alcohol and Other Drugs: Prevalence of Use and Related Harms: Detailed Report. Ottawa: Canadian Centre on Substance Abuse.

Saunders, J.B. Aasland, O.G., Babor, T.F., de la Fuente, J.R., & Grant, M. (1993). Development of the Alcohol Use Disorders Screening Test (AUDIT). WHO collaborative project on early detection of persons with harmful alcohol consumption II. *Addiction* 88, 791–804.

Simpson, H.M., Beirness, D.J., Robertson, R.D., Mayhew, D.R., & Hedlund, J.H. (2004). Hard core drinking drivers. *Traffic Injury Prevention* 5: 261–269.

Simpson, H.M., Mayhew, D.R., & Beirness, D.J. (1992). National Survey on Drinking and Driving 1988. Technical Report. Ottawa: Health and Welfare Canada and Transport Canada.

Simpson, H.M., Mayhew, D.R., & Beirness, D.J. (1996). Dealing with the Hard Core Drinking Driver. Ottawa: Traffic Injury Research Foundation.

Single, E., MacLennan, A., & MacNeil, P. (1994). Horizons 1994: Alcohol and Other Drug Use in Canada. Ottawa: Health Canada and the Canadian Centre on Substance Abuse.

Smiley, A.M. (1986). Marijuana: On road and driving simulator studies. *Alcohol, Drugs and Driving* 2(3,4): 121–134.

Transportation Research Board (1994). The Nature of, and the Reasons for, the Worldwide Decline in Drinking and Driving. Transportation Research Board Circular 422 (B.M. Sweedler, Ed.). Washington, DC: Transportation Research Board.

Williams, A.F., Peat, M.A., Crouch, D.J., Wells, J.K., & Finkle, B.S. (1985). Drugs in fatally injured young male drivers. *Public Health Reports* 100(1): 19–25.

Wilson, R.J. (1984). A National Household Survey on Drinking and Driving. Ottawa: Road Safety and Motor Vehicle Directorate, Transport Canada.