

Educational outcomes and adolescent *Cannabis* *use*

Michael Lynskey and Wayne Hall

National Drug and Alcohol Research Centre
University of New South Wales

Report prepared for the New South Wales
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Executive summary

The possibility that cannabis use may adversely affect the development of young people is an issue of considerable public concern. Cannabis use has increased among young Australians over the past 20 years. By 1996 around a third of 12 to 17 year olds had used cannabis at least once, and a third of males and a quarter of females had done so in the past year. Many of these cannabis users begin their use in their mid teens while they are still at school. Cannabis use impairs memory, attention and co-ordination so its use could interfere with school performance.

Cross-sectional surveys in the USA and Australia have found a correlation between cannabis use and low school commitment, poor school performance, truancy and early school leaving. That is, high school children who are regular cannabis users on average have a lower commitment to school, are more likely to be truant and are more likely to leave school earlier than peers who do not use cannabis.

There are four possible explanations for the relationships between cannabis use and poor school performance. Firstly, the effects of cannabis use may impair learning and school performance. Secondly, poor academic performance may increase the likelihood that young people will use cannabis. Third, cannabis use and poor school performance may be common reflections of a propensity to engage in problem behaviour. Fourth, cannabis use and poor school performance may be correlated because the factors that increase the risk of using cannabis are the same as, or overlap with, the factors that increase the risks of poor school performance.

Cross-sectional surveys do not permit us to distinguish between these four explanations because we do not know which came first – cannabis use or poor school performance - and we can only rarely look at the contribution of other factors to cannabis use and poor school performance. The explanations can only be distinguished by doing longitudinal research studies in which large representative samples of young people are studied before they begin using cannabis. They are then followed through high school and into early adult life with their educational performance and personal and social adjustment assessed at regular intervals. These types of longitudinal studies enable researchers to assess the extent to which early cannabis use precedes, and is a risk factor for, poor school performance and early school leaving. They also enable researchers to determine how much of the relationship between cannabis use and poor school performance is explained by the characteristics of children who are early initiators and regular cannabis users.

Several large longitudinal studies have now been conducted in New Zealand and the United States on the consequences of adolescent cannabis use. A number of these have included a variety of different measures of school performance, such as attitudes towards schooling, truancy, and early school leaving. These have generally shown that:

1. poor school performance in primary school and the early years of high school are risk factors for early cannabis use (that occurring before the age of 15);
2. cannabis use in early adolescence predicts poor school performance in high school, truancy and early school leaving; and

3. the relationship between cannabis use and these measures of poor school performance persists after statistically taking account of existing differences in school performance and other characteristics between children who do and do not start cannabis use before the age of 15 years.

It is possible that the relationship between cannabis use and early school leaving arises from the effects of factors that have not been measured in these studies. But this seems unlikely given that these relationships have been consistently found in different studies and a wide range of different factors have been statistically controlled for in these studies. It seems reasonable to conclude:

1. that children whose school performance is poor are more likely to be early cannabis users, and
2. that among these children early cannabis use further increases the risk of early school leaving.

A number of possible mechanisms have been hypothesised to explain why early cannabis use may increase the risks of early school leaving. One hypothesis is that daily cannabis use produces an 'amotivational syndrome' which is reflected in reduced commitment to and participation in schooling with predictable results for school performance. Research has not supported the existence of a unique cannabis 'amotivational syndrome' but daily cannabis use may impair motivation and performance.

A second hypothesis is that daily cannabis use produces cognitive deficits which impair school performance. Recent research has suggested that adults who have used cannabis daily over many years have subtle cognitive changes in the way that they attend to stimuli and process information. There is no evidence, however, of the severe memory deficits and cognitive impairment found in heavy alcohol consumers. There is very little direct evidence on cognitive impairment in adolescent cannabis users. The subtle changes found in adult cannabis users typically occur after many years of daily cannabis use. It is doubtful that many adolescent users have sustained such a history of cannabis use. Any cognitive impairment in cannabis using adolescents is more likely to reflect the acute effects of cannabis intoxication, that is, the effects on memory and attention experienced immediately after using cannabis.

A final possibility is that cannabis use is associated with the premature adoption of adult roles by young people who are not equipped to fulfil them. This hypothesis has been supported by research showing that early cannabis users are more likely to leave the family home, more likely to engage in adolescent sexual activity and to experience unplanned pregnancy and teenage childbirth. Cannabis use influences these outcomes indirectly through the social context within which cannabis is used, namely, within a peer group of other cannabis users who reject conventional values.

Conclusions and Implications

Early cannabis use probably makes a small contribution to poor educational performance and early school leaving. These effects reflect a combination of factors. The acute effects of cannabis intoxication exacerbate pre-existing school difficulties in young people who are most likely to use the drug before the age of 15 years. The social context of the peer group within which cannabis is regularly used by early cannabis users encourages them to prematurely adopt adult roles by leaving school early, leaving the parental home, and engaging in sexual activity that increases the chances of teenage pregnancy and childbirth.

Given the potentially adverse effects of poor school performance on life choices and chances, it is important to intervene to reduce or ameliorate the effects of early cannabis use on school performance. This requires a mix of strategies. These include providing additional support in literacy and numeracy for primary school children whose poor school performance puts them at risk of early cannabis use; broader-based early interventions for the families of primary school children who are at risk of a variety of adverse personal and social outcomes; education about the risks of cannabis use as part of health education about the risks of alcohol, tobacco and over-the-counter drugs; and early treatment interventions for adolescents who are daily or near daily cannabis users.

1 Introduction

Cannabis is widely used by young people in Australia (Lynskey et al, 1999) and many other countries, including New Zealand (Fergusson, Lynskey and Horwood, 1993), the United States (Johnston, O'Malley, and Bachman, 1998a) and Canada (Adlaf and Smart, 1991) (See Hall, Johnston and Donnelly (1999) for a review of the epidemiology of cannabis use).

Cannabis use is typically initiated during adolescence (Chen and Kandel, 1995), an important time of transition between childhood and adulthood. High school education is an important determinant of how well this transition is negotiated; its outcomes affect an individual's educational and career opportunities and ultimately an individual's life chances throughout adulthood. Cannabis is widely used by Australian adolescents and its effects include impairment of thinking, memory and psychomotor performance (Hall, Solowij and Lemon, 1994; Hall and Solowij, 1998). It is understandable that many parents and teachers are concerned about its potentially adverse effects on school performance.

The possible adverse effects of cannabis use on school performance are not the only source of parental concern about adolescent cannabis use. Parents are also concerned about the extent to which cannabis may be a 'gateway' drug, that is, whether its use may increase the likelihood that young people will use other more dependence producing and dangerous illicit drugs such as amphetamines, cocaine and heroin (Hall, Solowij and Lemon, 1994). There are also concerns about whether adolescents can become dependent on cannabis, and whether heavy cannabis use in adolescence may precipitate serious mental illness, such as a psychosis and schizophrenia, in vulnerable young people (Hall, 1998).

These concerns have prompted a substantial amount of research on adolescent cannabis use. This includes research on patterns of cannabis use, the reasons why young people use cannabis, and the social and psychological consequences of adolescent cannabis use in early adult life. Our focus in this report is on the extent to which cannabis use during adolescence interferes with educational performance and attainment. A brief summary of research findings on the gateway hypothesis, cannabis dependence and cannabis induced psychosis is provided in Appendix 1, along with suggestions for further reading.

This paper summarises research on the possible effects of cannabis use on educational attainment. Its specific aims are to:

1. describe research on patterns of cannabis use among Australian youth,
2. summarise research on relationships between cannabis use and school performance,
3. outline research on the most plausible explanations of the relationships between cannabis use and school performance.

2 Patterns of cannabis use

2.1 Cannabis the drug

Cannabis preparations are derived from the plant of *Cannabis sativa*. Their primary psychoactive constituent is delta-9-tetrahydrocannabinol (THC) (Adams and Martin, 1996). The THC content is highest in the flowering tops of the plant, declining in the leaves, lower leaves, stems and seeds. Marijuana (which has a THC content between 0.5% and 5%) is prepared from the dried flowering tops and leaves. Hashish (which has a THC content between 2% and 20%) consists of dried cannabis resin and compressed flowers. Hash oil may contain between 15% and 50% THC (Adams and Martin, 1996). The THC content of cannabis has probably increased in recent decades but, contrary to media reports, there is no evidence that it has increased 30 fold (see Appendix 2). More potent forms of the plant (such as the 'heads') are now more widely used (Hall and Swift, 1999).

Cannabis may be smoked in a 'joint', the size of a cigarette, or in a water pipe. Tobacco may be added to assist burning of marijuana or hashish. Smokers typically inhale deeply and hold their breath to maximise absorption of THC by the lungs. Marijuana and hashish may also be eaten but cannabis is most often smoked because this is the easiest way to achieve the desired level of intoxication (Hall et al, 1994).

2.2 The effects of cannabis

The major reason for using cannabis is to experience a subjective 'high', an altered state of consciousness which is characterised by mild euphoria and relaxation, and by perceptual alterations, such as time distortion, and the intensification of ordinary sensory experiences, such as eating, watching films, and listening to music (Jaffe, 1985; Tart, 1970). When used in a social setting the 'high' is often accompanied by infectious laughter, talkativeness, and increased sociability.

Cognitive changes are usually marked when 'high'. These include an impaired short-term memory, and a loosening of associations, which make it possible for the user to become lost in pleasant reverie and fantasy, while making it difficult to sustain goal-directed mental activity. Motor skills, reaction time and motor co-ordination are also affected so many forms of skilled psychomotor activity are impaired while the user is intoxicated (Jaffe, 1985).

Not all the effects of cannabis intoxication are welcomed by users. Some users report unpleasant psychological reactions, ranging from anxiety to panic reactions, and a fear of going mad (Smith, 1968; Weil, 1970; Thomas, 1993). These effects are most often reported by naive users who are unfamiliar with the effects of cannabis. More experienced users may also report these effects if they use a much larger than usual dose. Psychotic symptoms, such as delusions and hallucinations, are very rare experiences that occur at very high doses of THC, and perhaps in susceptible individuals at lower doses (Smith, 1968; Thomas, 1993; Weil, 1970).

2.3 The prevalence of cannabis use among young Australians

In 1996 the Anti-Cancer Council of Victoria conducted a national survey of tobacco, alcohol and illicit drug use among Australian secondary school students. The methods of sampling and data collection were identical to those used in previous studies (Hill et al, 1993) and have been described by Hill et al (1990). A detailed description of the prevalence of cannabis and other illicit drug use is provided by Lynskey et al (1999).

In the survey, 31,529 Year 7 to 12 students from a representative sample of schools throughout Australia were asked about their use of tobacco, alcohol and illicit drugs. Students were asked how often they had used cannabis (none; once or twice; 3-5 times; 6-9 times; 10-19 times; 20-39 times; 40 or more times) at any time in their lives (“lifetime use”) and during the past year (“past year use”).

Table 1 shows that 36.4% of all students aged between 12 and 17 years reported that they had used cannabis at least once. The prevalence of lifetime cannabis use increased with age, from 13.5% among 12 year olds to 55.4% among 17 year olds. At all ages, males were more likely to report cannabis use than females: 39.8% of all males aged 12 to 17 years reported having used cannabis, compared with 33.3% of females.

Table 1: Weighted prevalence (%) of lifetime cannabis use among males and females by age.

Age	Males	Females	Total
12 Years	16.8	10.1	13.5
13 Years	25.4	18.2	21.9
14 Years	37.8	31.0	34.5
15 Years	48.4	41.2	44.9
16 Years	53.2	46.3	49.7
17 Years	56.6	54.2	55.4
12-17 Years	39.8	33.3	36.4

Table 2 presents data on the frequency with which male and female students said that they had used cannabis in the past year. It shows that the majority of young people who had used cannabis did so on only a few occasions. For example, among the 32.3% of males who had used cannabis in the past year, 44% (14.2% of all males in the survey) reported that they had used cannabis on five or less occasions during the year. A small proportion of the sample (5%) reported using cannabis more than 40 times in the past year (approximately weekly use). Males (6.1%) were more likely to do so than females (2.9%).

Table 2: Frequency of cannabis use (%) in the past year among males and females aged 12-17 years.

Frequency of cannabis use in past year	Males	Females
Not Used	67.7	72.4
Once or Twice	9.2	8.9
3-5 Times	5.0	5.3
6-9 Times	4.0	3.7
10-19 Times	4.4	4.0
20-39 Times	3.6	2.8
40 + Times	6.1	2.9

The rates of use of other illicit drugs were substantially lower than those for cannabis. The next most commonly used illicit drugs after cannabis were the hallucinogens (e.g. LSD, "magic mushrooms"), which 9.8% of males and 7.5% of females aged 12 to 17 years said that they had used. Less than 1% of males and females reported using hallucinogens on 40 or more occasions in the past year. The lifetime use of other illicit drugs was lower still: amphetamines had been used at least once by 7.1% of males and 5.2% of females, cocaine by 4.6% of males and 2.6% of females, ecstasy by 4.4% of males and 2.9% of females, and opiates by 4.5% of males and 3.0% of females. Rates of regular use of any of these drugs were less than 1%.

Experienced cannabis users were also likely to use other drugs: 38.7% of those who reported having used cannabis on at least 10 occasions in the past year also reported the use of other illicit drugs compared with only 4.7% of those who did not report regular cannabis use. The rates of alcohol and tobacco use were also much higher among young people who reported regular cannabis use. Those who reported regular cannabis use were 5.9 times more likely to drink alcohol regularly, 7.7 times more likely to consume large quantities of alcohol, and 14.1 times more likely to be regular tobacco smokers than peers who did not report the use of cannabis (Lynskey et al, 1999).

2.4 Comparisons with previous studies

Table 3 compares the prevalence of cannabis use among students aged 12 to 17 years in the 1996 Australian School Students' Alcohol and Drugs Survey with that in earlier surveys in South Australia and NSW. These surveys include: a 1988 survey of 3036 South Australian school students (Christie et al, 1990); a 1989 survey of 3753 New South Wales school students (Donnelly et al, 1990); and a 1992 survey of 3828 New South Wales School students (Cooney, Dobbinson and Flaherty, 1994).

The comparison suggests there has been an increase in the prevalence of cannabis use among youth between 1988 and 1996. The earlier surveys suggest that approximately 25% of young people aged 12 - 17 years report that they had used cannabis at some time in their lives compared with 36% in the Australian School Students' Alcohol and Drugs Survey. At each age between 12 and 17 years the prevalence of cannabis use was higher in the 1996 national survey.

The suggestion of an increase in cannabis use among Australian youth is supported by the results of the National Drug Strategy (NDS) Household Survey. This survey has been conducted as part of the National Drug Strategy in 1985, 1988, 1991, 1993, 1995 and 1998. Williams (1997) found that NDS Household Surveys have shown an increase in the prevalence of cannabis use among youth. Among those aged 14-19 years, the prevalence of cannabis use in the past year rose from 20.8% in 1988 to 28.4% in 1995.

The 1998 NDS Survey revealed another increase in cannabis use among youth (Australian Institute of Health and Welfare, 1999). Among persons aged 14-19 years, just under half (44.6%) reported using cannabis at some time in their lives, and a third (34.6%) reported that they had used cannabis in the past year. The comparable rates in the 1995 NDS Survey were 35.5% and 28.4%. The increase was most marked among young women aged 14-19 years: the proportion who reported lifetime cannabis use increased from 24.4% in 1995 to 44.8% and use in the past year increased from 19.9% in 1995 to 34.2% in 1998 (AIHW, 1999). Over the same period, lifetime (44.7% and 44.5% respectively) and past year use of cannabis (35% and 35% respectively) remained stable among young males aged 14 to 19 years (AIHW, 1999).

Table 3: Comparison of reported rate (%) of lifetime cannabis use from selected survey

Age (years)	1988 South Australian Survey	1990 NSW School Students Survey	1992 NSW School Students Survey	1996 National School Students Survey
12	5.6	4.9	8.4	13.5
13	10.1	10.4	14.2	21.9
14	21.1	22.1	25.9	34.5
15	32.4	26.6	33.1	44.9
16	41.7	30.7	42.6	49.7
17	-	32.6	36.7	55.4
12-17	-	20.0	25.4	36.4

2.5 Comparisons between Australia and the United States

Finally, it is of interest to compare the prevalence of cannabis use among Australian youth with the corresponding prevalence estimates from overseas. Data from the United States has been selected for inclusion in this report, as the USA has the most comprehensive system for monitoring drug trends among youth. Its Monitoring the Future Survey (Johnston, O'Malley and Bachman, 1996) which has been conducted annually since 1975 includes four components: a) a survey of a representative sample of all seniors in public and private high schools in the conterminous United States; b) follow-up surveys of representative samples of young adults from previous graduating classes who are administered follow-up surveys by mail; c) representative samples of American college students one to four years past high school; d) surveys of eighth and tenth grade students.

Table 4 compares rates of cannabis use among Australian and American youth. The data from the USA is taken from the 1996 wave of the high school data collection to compare rates in the two countries at the same time. The comparisons in this Table should, however, be treated with some caution, as the methods of sampling and data collection are not identical in the two surveys. Additionally, the USA data is tabulated by school grade whereas the Australian data has been presented by student age. In making comparisons, the USA 8th grade data has been compared with 13 year old Australians, the USA 10th grade data has been compared with 15 year old Australians and the USA 12th grade data has been compared with 17 year old Australians. Table 4 indicates that the prevalence of cannabis use among Australian and American youth is roughly comparable, although there is some evidence that the lifetime prevalence of cannabis use may be slightly higher among 17 year old Australians.

Table 4: Comparison of the lifetime cannabis use percentage among Australian and American youth

	Australia	United States
8th Grade/13 years	21.9	23.1
10th Grade/15 years	44.9	39.8
12th Grade/17 years	55.4	44.9

The rise in the prevalence of cannabis use among Australian youth, discussed above, has been paralleled by similar trends in rates of cannabis use among United States school students between 1991 and 1997 (Johnstone, O'Malley and Bachman, 1998a). Between 1991 and 1997 the lifetime prevalence of cannabis use among eighth graders rose from 10.2% to 22.6%; that among tenth graders rose from 23.4% to 42.3% and that among twelfth graders rose from 36.7% to 49.6%. The most recent survey in 1998, suggests that the prevalence of cannabis use among American youth may have levelled off (Johnstone, O'Malley and Bachman, 1998b). Between 1997 and 1998 the lifetime prevalence of cannabis use remained stable at 22.6% and 22.2% among eighth graders. It dropped slightly from 42.3% to 39.6% among tenth graders, and it was stable at 49.6% and 49.1% among twelfth graders.

In summary, data from the most recent School Student and Household surveys indicate that cannabis is widely used among Australian youth with approximately two in every five young people reporting having used cannabis. Comparison of surveys across time suggests that there has been an increase in cannabis use among Australian youth, particularly among young women. Australian rates of use may be marginally higher than those in the USA but both countries have seen increasing rates of use over the past half decade.

3 Adolescent cannabis use and educational performance

A number of cross-sectional surveys have examined associations between cannabis use and measures of educational attainment and commitment among school children and youth. The measures of educational outcome have only rarely involved direct measures of school performance such as school grades or examination performances. More often these studies use indirect measures of school performance such as truancy and early school leaving because issues of confidentiality and privacy preclude access to information on school performance as assessed by grades and performance in external examinations. The variety and indirectness of the measures of educational performance makes comparison more difficult.

Resnick et al (1997) reported that high levels of “school connectedness” were associated with less frequent cannabis use whereas a low grade point average was associated with greater marijuana use in a USA national sample of 12,118 adolescents. Brook et al (1998) reported that among 1,687 Colombian adolescents those who were dissatisfied with school were more likely to use cannabis. Swaim, Bates and Shavez (1998) reported that good school adjustment, assessed by ratings of how much the young person liked school and how well they performed, was associated with lower rates of substance use among Mexican American students who had left school.

In an Australian study of 199 high school students aged 13-16 years, Jones and Heaven (1998) found that young people who were heavily involved using cannabis had a more negative attitude toward school and a poorer record of school attendance than those who were not involved. Lifrak et al (1997) reported a negative correlation between cannabis use and scholastic competence for boys (but not for girls) in a sample of 271 seventh and eighth grade students. Novins and Mitchell (1998) also reported a significant association between poor school performance and cannabis use for males (but not females) in a sample of 1464 American Indian adolescents. This association persisted after adjustment for antisocial behaviours, peer affiliations and other substance use.

A number of studies have shown that rates of cannabis and other illicit drug use are higher among young people who either no longer attend school or who are absent from school on any given day. For example, Lynskey et al (1999) found that young people in the Australian School Students’ Alcohol and Drugs Survey who reported being away from school the day before the survey had higher rates of cannabis use than students who attended school on that day. Similarly, Fergusson, Lynskey and Horwood (1995) found that truancy was more common among cannabis users in a sample of nearly 1,000 New Zealand children studied from birth to the age of 16 years. They found that 75.8% of those who reported frequent truancy had used cannabis compared with only 8.7% of those who reported no truancy. Finally, Swaim et al (1997) reported that lifetime rates of cannabis use were almost twice as high among school dropouts as among those who were still attending school.

Mensch and Kandel (1988) examined relationships between educational achievement and cannabis use in the USA National Longitudinal Survey of Young Adults. Using retrospective reports of cannabis use, they found that high school graduates

reported significantly more use of cannabis during adolescence than college graduates, even after controlling for socio-demographic factors, and differences in academic ability, self-esteem and delinquency. The value of the study was compromised by a reliance on retrospective reports of cannabis use, the reliability and validity of which have been questioned (Brewin et al, 1993).

Similarly, analyses of retrospective data from the National Comorbidity Study by Kessler, Foster, Saunders and Stang (1995) reported that substance use disorders in adolescence were associated with increased risks of leaving school early. Specifically, those who reported an early onset substance use disorder were 2.3 times more likely to leave school before graduating and 2.0 times more likely not to enter college. The authors concluded (page 1031) that:

“ ... early-onset psychiatric disorders have adverse personal consequences, through greater educational failure and its sequelae, for the individuals who experience them and have adverse consequences for the broader society in which these individuals live. A cost accounting of these and other consequences ... may well lead to the conclusion that we cannot afford to forgo the opportunity to develop early interventions and treatments to prevent these costly consequences for society and some of its most vulnerable citizens.”

4 Explaining the relationship between cannabis use and educational outcomes

The studies described above show that a variety of measures of poor educational outcomes, such as truancy, early school leaving and poor school performance, are more likely to occur among young people who begin cannabis use early (usually before the age of 15 years) and are regular cannabis users. The best explanation of these associations remains in contention. Four broad types of explanation need to be considered, namely: that cannabis use is one of the causes of poor educational performance; that poor performance is one of the causes of cannabis use; that cannabis use and poor educational performance are part of a syndrome of problem behaviour in adolescence; and that cannabis use and poor educational performance are not directly related but share common causes.

4.1. Cannabis use causes educational difficulties

The first and simplest explanation of the association is that early cannabis use causes poor educational outcomes. This explanation has been clearly articulated by Kandel, Davies, Karus and Yamaguchi (1986) who argue that: early cannabis use encourages continued use of the drug; cannabis and other illicit drug use encourages anti-conventional behaviours including early school leaving, delinquency, employment problems and difficulties in interpersonal relationships.

4.2. Cannabis use is a consequence of educational problems

An alternative explanation is that heavy cannabis use is a consequence of poor educational attainment. There is some support for this hypothesis in that poor educational performance is a risk factor for cannabis use and misuse (Hundelby and Mercer, 1987; Jessor, 1976; Kelly and Balch, 1971; Duncan et al, 1998). Hawkins et al (1992), who reviewed this evidence, concluded that poor educational performance and low commitment to school are risk factors that precede cannabis use. The hypotheses that cannabis use is a cause of poor school performance and that poor school performance is a cause of cannabis use are not mutually exclusive. Both processes can potentially operate concurrently, as has been noted by Krohn et al (1997). That is, poor school performance may increase the risks of using cannabis, which in turn may exacerbate poor school performance.

4.3. A common syndrome of problem behaviour

A third alternative explanation is that cannabis use and poor educational attainment are reflections of a common syndrome of problem behaviour. According to Jessor and Jessor's (1977) Problem Behaviour Theory, a wide range of problem behaviours occurring in adolescence are manifestations of a common syndrome or proclivity to problem behaviours. This common syndrome, which Donovan and Jessor (1985) subsequently suggested reflected unconventionality, is assumed to be the result of common personal and environmental influences which increase risks of norm violating and problem behaviour in general.

Most research on this theory has focussed on the extent to which correlations between problem behaviours can be explained by a single common factor. Such a factor has been described as problem behaviour or general deviance (McGee and Newcomb, 1992), a syndrome of problem behaviour (Donovan and Jessor, 1985) or simply as a common factor (Farrell et al, 1992). The results of these studies have been mixed. Some have reported a single factor (Donovan and Jessor, 1985; Donovan, Jessor, and Costa, 1988; Farrell et al, 1992; McGee and Newcomb, 1992) while other studies have not (Gillmore et al, 1991; Grube and Morgan, 1990).

4.4. Common causes

The final possibility is that the observed associations between early cannabis use and poor educational outcomes are not causal but are instead the result of common factors that increase the likelihood of both early cannabis use and poor educational performance. There is considerable indirect evidence to support this hypothesis because the risk factors and life pathways for early cannabis use overlap considerably with those for poor educational performance. These risk factors (see reviews by Hawkins et al, 1992; Kandel, 1980; Newcomb and Bentler, 1989) include: the extent to which the norms and attitudes of the wider community encourage or discourage the use of drugs; social disadvantage and family dysfunction; individual factors including personality and an individual's propensity to violate norms; and the extent to which an individual affiliates with delinquent and drug using peers.

5 Longitudinal studies of cannabis use and educational outcomes

5.1 The logic of longitudinal studies

The studies cited above show that young people who use cannabis are at increased risk of poor educational performance but cross-sectional surveys do not enable us to determine which is cause and which effect. That is, it is not possible to conclude from these studies whether the associations arise because: cannabis use causes educational difficulties; educational difficulties cause cannabis use; both are reflections of a common syndrome of 'problem behaviour' or both reflect the common influence of social, family, individual and peer factors which increase the risks of each outcome.

In order to distinguish between these explanations it is necessary to have data from prospective longitudinal studies. These are studies in which a large representative group of individuals are assessed over time on cannabis use, educational attainment and other potentially confounding factors, such as family and social circumstances, personality characteristics and delinquency. Such longitudinal studies have a number of major advantages over cross-sectional studies (Rutter, 1988). First, they enable researchers to specify which comes first, cannabis use or poor educational performance. Second, they reduce the effects of recall bias from retrospective reports of cannabis use and behaviour. Third, they permit researchers to examine causal pathways between cannabis use and educational outcomes by statistical adjustment for the contribution of confounding variables. In particular, they enable researchers to answer the question: do young people who use cannabis have poorer educational outcomes than those who do not, when we allow for the fact that cannabis users are more likely to have a history of poor school performance before they used cannabis?

A number of recent prospective longitudinal designs have examined the associations between cannabis use and educational attainment. A key aim of many of these studies has been to determine whether or not early cannabis use is a risk factor which increases individuals' risks of early school leaving and other adverse educational outcomes.

These studies have assessed cannabis use and educational performance on a number of occasions over time. They have also assessed factors on which cannabis users and non-users may differ, such as socio-demographic factors, family and peer substance use and delinquency. They have also used statistical methods (typically regression models) to assess the extent to which prior cannabis use is associated with subsequent educational performance after the effects of potentially confounding covariates have been taken into account.

5.2 Major longitudinal studies of cannabis use and educational outcomes

Newcomb and Bentler (1988) used data collected over 8 years on a sample of 654 high school students to examine the impact of early substance use on a range of outcomes at ages 19 to 24 years. These outcomes included interpersonal relationships, family formation and stability, criminality, educational attainment, employment and mental health. These authors used structural equation modelling to examine the extent to which substance use (assessed by reports of cannabis, alcohol and drug use) was associated with

adverse outcomes in young adulthood, after taking account of the effects of antecedent confounding factors. Their analyses indicated that early substance use made significant independent contributions to several outcomes assessed in young adulthood. The authors concluded (page 205) that adolescent substance use

"leads to problems in several areas of life including livelihood, emotional functioning, criminal involvement, and an abandonment of traditional pursuits, such as a college education."

"Early substance use" was measured by the extent of use of alcohol, tobacco, cannabis and other illicit drugs but cannabis use was very highly correlated with substance use ($r=0.98$) so the effects of "early substance use" are strongly related to the effects of cannabis use. The results of this study have been supported in a study by Fergusson, Lynskey and Horwood (1996). These authors examined the extent to which cannabis use before the age of 15 years predicted regular drug use, criminal offending, poor mental health and reduced life opportunities at age 16, after adjusting for a range of potentially confounding factors. The sample consisted of nearly 1000 young people who had been followed from birth to age 16 years. They were assessed on cannabis use at age 15 and on cannabis use and a wide range of other health and psychological outcomes at age 16.

The ten percent of the sample who had used cannabis by the age of 15 had elevated risks of substance abuse, delinquency, school problems and poor mental health at age 16. Specifically, 22.5% had left school before age 16 (the minimum school leaving age in New Zealand) compared with only 3.5% of those who had not used cannabis. The frequency of truancy between 15 and 16 years was also higher among those who had used cannabis before the age of 15 years (31.5%) than those who had not used cannabis (4.7%).

Fergusson and colleagues also found that young people who reported cannabis use before age 15 differed from those who had not *prior* to using cannabis. They showed early tendencies to delinquency, poorer mental health and educational achievement, more affiliations with delinquent or substance using peers, and more family dysfunction. Fergusson et al used statistical methods to take account of these pre-existing differences between early cannabis users and their non-using peers. These analyses indicated that the associations between early onset cannabis use and the majority of the outcomes were no longer statistically significant, after the effects of these differences had been taken into account. This suggested that early cannabis use did not causally influence risks of alcohol abuse, daily tobacco use, conduct disorder, self report offending, anxiety disorders, depression or suicidal ideation.

In contrast, the relationship between early cannabis use and early school leaving persisted after statistical adjustment. After allowing for the effects of the pre-existing differences, young people who used cannabis before the age of 15 years were 3.1 (95% CI = 1.2 to 7.9) times more likely to leave school before age 16 than peers who had not used cannabis. In a later follow-up of the same birth cohort, Fergusson and Horwood (1997) reported that cannabis use before the age of 16 years was associated with an increased risk of leaving school without formal qualifications. This relationship persisted after control for a wide range of potentially confounding covariates.

Duncan et al (1998) examined substance use over time and the factors that predicted escalation of substance use in 664 adolescents who were assessed at three time points. They found that academic failure predicted higher levels of substance use (including cannabis use) at the initial time period. Deteriorating academic performance over the course of the study was also associated with increasing substance use. The authors acknowledged that substance use might have contributed to academic failure, but argued that academic failure was more likely to be a cause of increasing substance use. They suggested that much of the apparent effect of cannabis use on academic performance occurred through affiliations with delinquent or substance using peers.

Ellickson et al (1998) conducted a prospective longitudinal study in which they assessed cannabis use and a range of other factors in a sample of seventh graders who were followed up five years later. The results indicated that cannabis use predicted early school leaving among Latino students, even after controlling for demographic variables, family structure, academic orientation and early deviance. Young Latinos who were heavy cannabis users were 38% more likely to leave school before graduating. After controlling for these confounding factors, cannabis use did not predict leaving school early for Asians, Blacks or Whites.

Garnier, Stein and Jacobs (1997) conducted a long-term prospective study of early high school drop-out. They reported that early school leaving was determined by multiple factors, which included adolescent drug use. They found that, after taking account of a range of other determinants of early school leaving, there was still a significant association between drug use assessed at age 17 years and early school leaving. These authors did not report the effects of cannabis use on school leaving, but cannabis use was highly correlated with their measure of drug use.

Krohn, Lizotte and Perez (1997) reported that the use of alcohol and other drugs during adolescence increased the risks of precocious transitions to a range of adult roles, including leaving school early. They used prospective longitudinal data from a sample of 775 high-risk adolescents studied from age 13 to 20 years. Early substance use, measured by self-reported frequency of alcohol, cannabis and other illicit drug use, predicted early school leaving for males but not for females.

Tanner, Davies and O'Grady (1999) used data from the National Longitudinal Study of Youth to examine the influence of drug use (assessed between 14 and 17 years) on social outcomes assessed between the ages of 25 to 30 years. These included educational outcomes (highest grade completed, graduation from high school, college degree) and employment variables (occupational status, unemployment). Their analyses indicated that, after controlling for socio-demographic background, cognitive skill and educational expectations, early drug use was a significant predictor of early school drop out, failure to graduate from high school and failure to obtain a college degree in both males and females. Among males early drug use was also related to lower occupational status and unemployment.

Similar findings have been reported in a recent study by Brook, Balka and Whiteman (1999) in which a sample of 1182 Puerto Rican and African American students were followed over a five year period. Young people who reported using cannabis once a month or more often at age 14 were more likely to leave high school before completing 12th grade, even after controlling for a range of factors assessed at age 14. Additionally, young people who used cannabis at least monthly at age 14 years were more likely to

report delinquency, other drug related problems, sexual risk taking and to have more friends who exhibited deviant behaviour.

In summary, there have now been a number of longitudinal research studies that have examined the influence of cannabis use on a variety of different measures of subsequent educational performance. These have generally shown that early cannabis use is a risk factor for poor educational outcomes and, in particular, early school leaving.

A causal interpretation of the link between early cannabis use and subsequent educational performance has been supported by the fact that many of these studies have statistically controlled for a wide range of variables on which cannabis users and non-users differ.

In these studies early cannabis use predicts an increased risk of early school leaving and making precocious transitions to adult roles by engaging in early sexual activity (Rosenbaum and Kandel, 1990), unplanned parenthood during adolescence (Krohn et al, 1997; Mensch and Kandel, 1992), unemployment (Fergusson and Horwood, 1997), and leaving the family home early (Krohn et al, 1997).

6 Explanations of the association between cannabis use and early school leaving

The prospective studies indicate that young people who begin the use of cannabis (and other drugs) at an early age have an increased risk of poor school performance and early school leaving. A number of explanations have been proposed to explain this association.

6.1. The association arises from the effects of uncontrolled factors

There is still debate about whether the relationship between early cannabis use and early school leaving arises because cannabis use is a cause of early school leaving. The longitudinal studies have ensured that cannabis use has been assessed before leaving school and that statistical methods have taken account of a wide range of potential explanations of the association between cannabis use and early school leaving. Perhaps the most comprehensive effort to take account of other possible explanations was in the study by Fergusson et al (1996). Their results, and those of other studies, indicate that, even though statistical control substantially reduces the associations between cannabis use and early school leaving, a significant association remains.

It is still possible that the association between cannabis use and early school leaving arises from the effects of factors that were not measured in the studies. This possibility has been highlighted by authors who have suggested that neighbourhood effects (Ensminger, Lamkin and Jacobson, 1996) and genetic vulnerability (Plomin and Craig, 1997) may explain the relationships.

Difficulties in drawing causal inferences are not peculiar to studies of the relationship between cannabis use and early school leaving. A number of studies, for example, have found a relationship between cigarette smoking and early school leaving which remains after extensive statistical control for confounding factors (Ellickson et al, 1998; Fergusson and Horwood, 1997). There is no obvious biological explanation of the relationship so it is more likely to reflect uncontrolled factors that are associated with increased risks of tobacco use and increased risks of early school leaving. Although a similar possibility cannot be excluded with respect to cannabis, the relationship between cannabis use and early school leaving does have a number of plausible explanations.

6.2. Cannabis use produces an 'amotivational' syndrome

Daily cannabis use over months and years has been reported to impair motivation and social performance in societies with a long history of use, such as Egypt and the Caribbean (e.g., Brill and Nahas, 1984). Increasing cannabis use in the USA in the early 1970s produced clinical reports of a similar syndrome occurring among heavy cannabis users (e.g., Kolansky and Moore, 1971; Millman and Sbriglio, 1986; Tennant and Groesbeck, 1972). These typically described users whose focus of interest was narrowed, who were apathetic, withdrawn, lethargic, unmotivated and showed impaired memory, concentration and judgement (Brill and Nahas, 1984; McGlothlin and West, 1968). This constellation of symptoms was described as an "amotivational syndrome" (e.g., McGlothlin and West, 1968; Smith, 1968). These studies were uncontrolled so it was not possible to disentangle the effects of chronic cannabis use from those of poverty

and low socioeconomic status, or pre-existing personality and other psychiatric disorders (Millman and Sbriglio, 1986; National Academy of Science, 1982; Hall et al, 1994).

The existence of an amotivational syndrome among chronic heavy cannabis users has not been supported by the results of a number of field studies conducted in societies where heavy cannabis use is widespread, including Jamaica (Rubin and Comitas, 1975) and Costa Rica (Carter et al, 1980). For example, Rubin and Comitas (1975) used videotapes to assess movement and biochemical measures of caloric expenditure before and after cannabis use in a group of Jamaican farmers who were regular users. Contrary to expectations, the workers engaged in more intense and concentrated labour after smoking cannabis. Unsupportive results were also reported by Carter et al (1980), who compared groups of cannabis users and non-users in Costa Rica. While non-users were more likely to have a stable employment history than users, those who were employed and had steady jobs smoked considerably more cannabis than those who had an unstable employment history or were unemployed.

Other evidence suggests that an amotivational syndrome is rare, if it exists. Halikas et al (1982) followed up 100 regular cannabis users over six to eight years and asked about symptoms of an amotivational syndrome. They found only three individuals who had experienced such a cluster of symptoms in the absence of significant depression. They were not distinguished from the other sample members by their extent of cannabis use. Nor were these symptoms related to changes in pattern of cannabis use; rather they seemed to come and go independently of cannabis use.

There have been a number of laboratory studies of long-term heavy cannabis use which have also failed to provide evidence of impaired motivation (Edwards, 1976). One study using standardised measures of performance failed to observe any effects on motivation (Mendelson et al, 1974). Subjects in this study were given access to as much cannabis as they earned by performing a simple task. Results showed that output was unaffected by cannabis use. This was in sharp contrast to the effects of alcohol: when the same study design was used with heavy drinkers performance was profoundly disrupted.

The research literature on the amotivational syndrome has been reviewed by Hall, Solowij and Lemon (1994) who conclude (page 105) that:

"The evidence for an amotivational syndrome among adults is, at best equivocal. The positive evidence largely consists of case histories, and observational reports. The small number of controlled field and laboratory studies have not found compelling evidence for such a syndrome, although their evidential value is limited by the small sample sizes and limited sociodemographic characteristics of the field studies, by the short periods of drug use, and the youthful good health and minimal demands made of the volunteers observed in the laboratory studies. It nonetheless is reasonable to conclude that if there is such a syndrome, it is a relatively rare occurrence, even among heavy, chronic cannabis users."

A recent review by Channabasavanna, Paes and Hall (1999) came to a similar conclusion. They concluded that, although some heavy users who requested assistance reported impaired motivation: “a well defined amotivational syndrome has not been documented.” They suggested that: “ it may be more parsimonious to regard impaired motivation as a symptom of chronic cannabis intoxication.” (p 277).

6.3. Cannabis use may produce cognitive deficit

A third explanation is that cannabis use causes cognitive impairments, which in turn impair school performance and increases the likelihood of leaving school early. In a recent review of this issue, Solowij (1998) concluded that long-term cannabis use did not produce gross cognitive deficits, that is, marked impairments in thinking and memory that could be as easily detected as those frequently found in long-term heavy alcohol consumers. This conclusion has recently been supported by the results of a prospective study of a large representative sample of the population (Lyketsos et al, 1999) which found no difference in rates of cognitive decline between persons who did and did not use cannabis. Solowij (1998) has argued, however, that daily or near daily cannabis use over periods of three or more years does produce subtle impairment in selective attention and the ability to ignore irrelevant sensory information.

Solowij (1998) noted that it was difficult to predict how these subtle impairments would affect adolescent functioning in school. Highly sophisticated methods of testing were necessary to detect these effects in adults and few adolescent cannabis users would have used cannabis intensively or long enough to produce the effects found in adults. The adults in the studies reviewed by Solowij (1998), for example, used cannabis daily for an average of 10 years. By contrast, in the study reported by Fergusson and Horwood (1997) the ‘heavy’ cannabis use group included those who had smoked cannabis on at least ten occasions. There is no evidence in the scientific literature on adults that such low levels of use are associated with any lasting cognitive impairment.

This does not mean that acute cognitive impairment is irrelevant in adolescents. It suggests that cognitive impairment in cannabis-using adolescents is more likely to be the result of the acute effects of cannabis intoxication rather than the effects of long-term use. If cannabis intoxication became an everyday occurrence in the life of an adolescent their school performance would suffer, and especially if it was poor or below average to begin with.

6.4. Early cannabis use leads to the precocious adoption of adult roles

Another hypothesis is that early cannabis use increases the chances of a precocious transition to adult roles, which includes early school leaving. There is some support for this hypothesis in that a number of studies have shown that adolescent cannabis use is associated with early marriage, early pregnancy and childbirth, and early school leaving.

Fergusson and Horwood (1997) have argued that much of the apparent influence of early cannabis use on later development can be attributed to the social setting in which regular cannabis-using adolescents typically use cannabis, namely within a group of delinquent

and substance using peers. Their views are in agreement with those of Kandel et al (1986) who argued that early substance use sets in train a cascade of events that increases later psychosocial risk. Fergusson and Horwood (1997; page 294) concluded:

"Most of the elevated risk seen among early onset cannabis users is likely to arise from factors that were antecedent to the decision to use cannabis, rather than as a consequence of cannabis use. Nonetheless, early onset usage is not without risks and those engaging in these behaviours may be more vulnerable to later psychosocial problems as a result of the social context within which cannabis is used and obtained."

On Fergusson and Horwood (1997)'s hypothesis, the important causal factor is that cannabis use occurs in a peer group that rejects conventional values, such as high educational achievement and social conformity, and which instead encourages non-conformist behaviour and a premature transition to adulthood.

7 Summary

The cross-sectional and prospective research indicates that young people who use cannabis are at increased risk of various adverse social outcomes including substance use and abuse, criminal behaviour, poor mental health, impaired educational achievement and reduced life opportunities. The longitudinal studies suggest that a large part of these associations arise because the factors that predispose young people to use cannabis overlap with the same factors that predict higher risk of these adverse outcomes. In ordinary language, the young people who are most likely to use cannabis in early adolescence are the same young people who were at greatest risk of using other drugs, engaging in minor delinquency, having poorer mental health and doing poorly at school before they began to use cannabis.

However, not all of the relationship between cannabis use and poorer social outcomes can be explained this way. There is evidence that early cannabis use independently increases the risks of regular substance use and early school leaving. That is, regular cannabis use further impairs the school performance of adolescents whose performance was poor before they began to use cannabis.

A plausible mechanism that may explain these associations has been suggested by Fergusson and Horwood (1997), namely, that early cannabis use increases the chances of adopting an unconventional lifestyle characterised by affiliations with delinquent and substance-using peers and disengagement from conventional social roles including completing education and obtaining employment. The acute effects of cannabis intoxication may also play a role, particularly among the minority of students who are daily cannabis users.

These results have a number of implications for the identification and remediation of poor school performance related to cannabis use. The strong association between regular cannabis use by adolescents and poor school performance means that children who perform poorly in primary school years are among those at greatest risk of early cannabis use. It also means that cannabis users are likely to be over-represented among adolescents who perform poorly in high school. In so far as the relationship is causal, additional support in literacy and numeracy for poor performers in primary school may be an effective way of reducing early and heavy cannabis use in adolescence. In the early years of high school, as well as additional support in literacy and numeracy, schools may also need to pay more attention to identifying and intervening with problem cannabis and alcohol use in poor school performers.

The implications for prevention of cannabis use among school students are less clear cut because early cannabis users have a range of social adversities and other problem behaviour. Early cannabis use shares a set of risk factors (such as social disadvantage, family problems, familial conflict and parental drug and alcohol problems) with other adverse social outcomes, such as delinquency, early sexual activity, teenage pregnancy, depression and attempted suicide (Fergusson and Horwood, 1997). This suggests that efforts to prevent cannabis use should be part of broadly targeted intervention strategies in early childhood rather than the focus of interventions directed only at cannabis use. A realistic goal of such programs may be to reduce the contribution that cannabis use makes to the poor school performance of high risk and disadvantaged adolescents whose poor performance in primary school puts them at increased risk of early initiation into cannabis use and early school leaving.

Specific interventions may be required for adolescents who are involved in regular cannabis use. The development, trial and evaluation of treatment programs for this group of adolescents is a priority. Policies of school expulsion or criminal prosecution are unlikely to reduce cannabis use; they are a form of enforced early school leaving that is more likely to entrench these young people in a deviant sub-culture and lifestyle.

This review suggests a number of research priorities. The evaluation of early intervention programs for children at risk of cannabis use and other adverse social outcomes is an obvious social and research priority because it will assist in deciding what role cannabis plays in poor school performance. If, for example, cannabis use does contribute to poor school performance, then at-risk children who are diverted from using cannabis will perform better in school than those who use cannabis.

A second research priority would be to obtain data from prospective studies of Australian adolescents to discover to what extent the findings of prospective studies in the USA and New Zealand are applicable to Australia. This need not involve designing new prospective studies that will not produce results for a decade or more. Such prospective studies may be a worthwhile investment of research funds for other reasons (e.g. to better understand adolescent health and development more generally). Any such studies that are undertaken

should collect information on cannabis and other drug use. In the interim, advantage should be taken of the Australian prospective studies that have been initiated in the past decade or so. Some of these already have collected information on alcohol, tobacco and cannabis use that could be used to examine relationships between cannabis use and educational outcomes. Other studies could include questions on cannabis use in subsequent data collections. It would be desirable, if possible, for some of these studies to examine the relationship between cannabis use and educational outcomes measured by school examination performance.

- Adams, I. B. and Martin, B. R. (1996) Cannabis: pharmacology and toxicology in animals and humans. *Addiction*, 91, 1585-1614.
- Adlaf, E. M. and Smart, R.G. (1991) Drug use among adolescent students in Canada and Ontario: The past, present and future. *Journal of Drug Issues*, 21, 59-72.
- Australian Institute of Health and Welfare (1999) 1998 *National Drug Strategy Household Survey*. Australian Institute of Health and Welfare, Canberra.
- Brewin, C. R., Andrews, B., and Gotlib, I. H. (1993). Psychopathology and early experience: a reappraisal of retrospective reports. *Psychological Bulletin*, 113, 82-98.
- Brill, H. and Nahas, G. G. (1984). Cannabis intoxication and mental illness. In G Nahas (Ed.), *Marihuana in Science and Medicine*. New York: Raven Press.
- Brook, J. S., Balka, E. B., and Whiteman, M. (1999). The risks for late adolescence of early adolescent marijuana use. *American Journal of Public Health*, 89, 1549-1554.
- Brook, J. S., Brook, D. W., De La Rosa, M., et al (1998). Pathways to marijuana use among adolescents: Cultural, ecological, family, peer and personality influences. *Journal of the American Academy of Child and Adolescent Psychiatry*, 37, 759-766.
- Carter, W. E., Coggins, W., and Doughty, P. L. (1980). *Cannabis in Costa Rica: A study of chronic marijuana use*. Philadelphia: Institute for the Study of Human Issues.
- Channabasavanna, S., Paes, M. and Hall, W. (1999) Mental and behavioural disorders due to cannabis. In: Kalant, H., Corrigal, W., Hall, W. and Smart, R. (Eds.), *The Health Effects of Cannabis*. (pp 267-290) Addiction Research Foundation, 1999.
- Chen, K., and Kandel, D. B. (1995). The natural history of drug use from adolescence to the mid-thirties in a general population sample. *American Journal of Public Health*, 85, 41-47.
- Christie, P., Cormack, S., Wyllie, C., and Bungey, J. (1990). *Survey of alcohol, tobacco and other drug use by South Australian schoolchildren*, 1988. Final report. Adelaide: Drug and Alcohol Services Council.
- Cooney, A., Dobbins, S., and Flaherty, B. (1994). 1992 *Survey of drug use by NSW secondary school students*. Sydney: NSW Health.
- Donnelly, N., Flaherty, B., Quine, S., et al. (1990). 1989 *Survey of drug use by NSW secondary school students*. Sydney: NSW Department of Health.
- Donovan, J. E., and Jessor, R. (1985). Structure of problem behaviour in adolescence and young adulthood. *Journal of Consulting and Clinical Psychology*, 53, 890-904.
- Donovan, J. E., Jessor, R., and Costa, F. M. (1988). Syndrome of problem behaviour in adolescence: A replication. *Journal of Consulting and Clinical Psychology*, 56, 762-765.
- Duncan, S. C., Duncan, T. E., Biglan, A., and Ary, D. (1998). Contributions of the social context to the development of adolescent substance use: a multivariate latent growth modelling approach. *Drug and Alcohol Dependence*, 50, 57-71.
- Edwards, G. (1976) Cannabis and the psychiatric position. In J.D.P. Graham (ed) *Cannabis and Health*. (pp 321-342). London: Academic Press.
- Ellickson, P., Bui, K., Bell, R., and McGuigan, K. A. (1998). Does early drug use increase the risk of dropping out of high school? *Journal of Drug Issues*, 28, 357-380.

- Ensminger, M. E., Lamkin, R. P., and Jacobson, N. (1996). School leaving: A longitudinal perspective including neighbourhood effects. *Child Development*, 67, 2400-2416.
- Farrell, A. D., Danish, S. J., and Howard, C. W. (1992). Relationship between drug use and other problem behaviours in urban adolescents. *Journal of Consulting and Clinical Psychology*, 60, 705-712.
- Fergusson, D. M. and Horwood, L. J. (1997). Early onset cannabis use and psychosocial adjustment in young adults. *Addiction*, 92, 279-296.
- Fergusson, D. M., Lynskey, M. T., and Horwood, L. J. (1993). Patterns of cannabis use among 13-14 year old New Zealanders. *New Zealand Medical Journal*, 106, 247-250.
- Fergusson, D. M., Lynskey, M. T., and Horwood, L. J. (1996). The short term consequences of early cannabis use. *Journal of Abnormal Child Psychology*, 24, 499-512.
- Fergusson, D.M., Lynskey, M.T. and Horwood, L.J. (1995). Truancy in adolescence. *New Zealand Journal of Educational Studies*, 30, 25-38.
- Garnier, H. E., Stein, J. A., and Jacobs, J. K. (1997). The process of dropping out of high school: A 19-year perspective. *American Educational Research Journal*, 34, 395-419.
- Gillmore, M. R., Hawkins, J. D., Catalano, R. F., Day, L. E., Moore, M., and Abbott, R. (1991). Structure of problem behaviours in preadolescence. *Journal of Consulting and Clinical Psychology*, 59, 499-506.
- Grube, J. W. and Morgan, M. (1990). The structure of problem behaviours among Irish adolescents. *British Journal of Addiction*, 85, 667-685.
- Halikas, J. A., Weller, R. A., Morse, C., and Shapiro, T. (1982). Incidence and characteristics of amotivational syndrome, including associated findings, among chronic marijuana users. In *National Institute on Drug Abuse, Marijuana and Youth: Clinical observations on motivation and learning*. Rockville, Maryland: National Institute on Drug Abuse.
- Hall, W. (1998). Cannabis and psychosis. *Drug and Alcohol Review*, 17, 433-444.
- Hall, W., Johnston, L. and Donnelly, N. (1999). The epidemiology of cannabis use and its consequences. In: Kalant, H., Corrigal, W., Hall, W. and Smart, R. (Eds.), *The Health Effects of Cannabis*. Addiction Research Foundation.
- Hall, W. and Solowij, N. (1998). The adverse effects of cannabis use. *Lancet*, 352, 1611-1616.
- Hall, W. Solowij, N., and Lemon, J. (1994). *The health and psychological consequences of cannabis use*. Canberra: Commonwealth Department of Human Services and Health.
- Hall, W. and Swift, W. (1999) *The THC content of cannabis in Australia: evidence and policy implications*. National Drug and Alcohol Research Centre, Technical Report Number 71, Sydney, 1999.
- Hawkins, J. W. Catalano, R. F. and Miller, J. Y. (1992). Risk and protective factors for alcohol and other drug problems in adolescence and young adulthood. *Psychological Bulletin*, 112, 64-105.
- Hill, D. J., White, V. M., Pain, M. D. and Gardner, G. J. (1990). Tobacco and alcohol use among Australian secondary school students in 1987. *Medical Journal of Australia*, 152, 124-130.
- Hill, D. J., White, V. M., Williams, R. M. and Gardner, G. J. (1993). Tobacco and alcohol use among Australian secondary school students in 1990. *Medical Journal of Australia*, 158, 228-234.
- Hundelby, J. D. and Mercer, G. W. (1987). Family and friends as social environments and their relationship to young adolescents' use of alcohol, tobacco, and marijuana. *Journal of Clinical Psychology*, 44, 125-134.
- Jaffe, J. H. (1985). Drug addiction and drug abuse. In A.G. Gilman, L.S Goodman and F. Murad (Eds.), *The Pharmacological Basis of Therapeutics* (7th ed., pp. 532-581). New York: Macmillan.
- Jessor, R. (1976). Predicting time of onset of marijuana use: A developmental study of high school youth. *Journal of Consulting and Clinical Psychology*, 44, 125-134.

- Jessor, R., and Jessor, S. L. (1977). *Problem Behavior and Psychosocial Development: A Longitudinal Study of Youth*. New York: Academic Press.
- Johnston, L. D., O'Malley, P. M., and Bachman, J. G. (1998a). *National survey results on drug use from the Monitoring the Future study, 1975-1997: Volume 1. Secondary school students*. Washington, DC: USA Department of Health and Human Services.
- Johnston, L. D., O'Malley, P. M. and Bachman, J. G. (1998b). *Drug use by American young people begins to turn downward*. [On-line]. Available: www.isr.umich.edu/src/mtf; accessed 02/09/1999.
- Jones, S. P. and Heaven, P. C. L. (1998). Psychosocial correlates of adolescent drug-taking behaviour. *Journal of Adolescence*, 21, 127-134.
- Kandel, D. B. (1980). Drug and drinking behavior among youth. *Annual Review of Sociology*, 6, 235-285.
- Kandel, D. B., Davies, M., Karus, D. and Yamaguchi, K. (1986). The consequences in young adulthood of adolescent drug involvement. *Archives of General Psychiatry*, 43, 746-754.
- Kelly, D. H. and Balch, R.W. (1971). Social origins and school failure: A reexamination of Cohen's theory of working-class delinquency. *Pacific Social Review*, 14, 413-430.
- Kessler, R. C., Foster, C. L., Saunders, W. B. and Stang, P. E. (1995). Social consequences of psychiatric disorders, I: Educational attainment. *American Journal of Psychiatry*, 152, 1026-1032.
- Kolansky, H. and Moore, W. T. (1971). Effects of marihuana on adolescents and young adults. *Journal of the American Medical Association*, 216, 486-492.
- Krohn, M. D., Lizotte, A. J., and Perez, C. M. (1997). The interrelationship between substance use and precocious transitions to adult statuses. *Journal of Health and Social Behavior*, 38, 87-103.
- Lyketos, C.G., Garrett, E., Liang, K.Y. and Anthony, J.C. (1999) Cannabis use and cognitive decline in persons under 65 years of age. *American Journal of Epidemiology*, 149, 794-800.
- Lifrak, P. D., McKay, J. R., Rostain, R., et al (1997). Relationship of perceived competencies, perceived social support, and gender to substance use in young adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry*, 36, 933-940.
- Lynskey, M., White, V., Hill, D., Letcher, T. and Hall, W. (1999). The prevalence of illicit drug use among youth: Results from the Australian School Students' Alcohol and Drugs Survey. *Australian and New Zealand Journal of Public Health*, 23, 519-524.
- McGee, L. and Newcomb, M. D. (1992). General deviance syndrome: Expanded hierarchical evaluations at four ages from early adolescence to adulthood. *Journal of Consulting and Clinical Psychology*, 60, 766-776.
- McGlothlin, W. H., and West, L. J. (1968). The marijuana problem: An overview. *American Journal of Psychiatry*, 125, 370-378.
- Mendelson, J. H., Rossi, A. M. and Meyer, R. E. (1974). *The use of marihuana: A psychological and physiological inquiry*. New York: Plenum Press.
- Mensch, B. S. and Kandel, D. B. (1988). Dropping out of high school and drug involvement. *Sociology of Education*, 61, 95-113.
- Mensch, B. and Kandel, D. B. (1992). Drug use as a risk factor for premarital teen pregnancy and abortion in a national sample of young white women. *Demography*, 29, 409-429.
- Millman, R. B. and Sbriglio, R. (1986). Patterns of use and psychopathology in chronic marijuana users. *Psychiatric Clinics of North America*, 9, 533-545.
- National Academy of Science (1982). *Marijuana and health*. Washington, DC: National Academy Press.
- Newcomb, M. D. and Bentler, P. M. (1988). *Consequences of adolescent drug use: Impact on the lives of young adults*. Newbury Park, CA: Sage.

- Newcomb, M. D. and Bentler, P. M. (1989). Substance use and abuse among children and teenagers. *American Psychologist*, 44, 242-248.
- Novins, D. K. and Mitchell, C. M. (1998). Factors associated with marijuana use among American Indian adolescents. *Addiction*, 93, 1693-1702.
- Plomin, R. and Craig, I. (1997). Human behavioural genetics of cognitive abilities and disabilities. *Bioessays*, 19, 1117-1124.
- Resnick, M. D., Bearman, P. S., Blum, R. W., et al (1997). Protecting adolescents from harm: Findings from the National Longitudinal Study on Adolescent Health. *Journal of the American Medical Association*, 278, 823-832.
- Rosenbaum, E. and Kandel, D. B. (1990). Early onset of adolescent sexual behavior and drug involvement. *Journal of Marriage and the Family*, 52, 783-798.
- Rubin, V. and Comitas, L. (1975). *Ganja in Jamaica: A medical anthropological study of chronic marihuana use*. The Hague: Mouton Publishers.
- Rutter, M. (1988). Longitudinal data in the study of causal processes: Some uses and some pitfalls. In M. Rutter (Ed.), *Studies of Psychosocial Risk: The Power of Longitudinal Data* (pp. 1-28). Cambridge: Cambridge University Press.
- Smith, D. E. (1968). Acute and chronic toxicity of marijuana. *Journal of Psychedelic Drugs*, 2, 37-47.
- Solowij, N. (1998). Long-term effects of cannabis on the central nervous system. In H. Kalant, W. Corrigall, W. Hall, R. Smart (Eds.), *The Health Effects of Cannabis* (pp. 195-266). Toronto: Addiction Research Foundation.
- Swaim, R. C., Bates, S. C. and Chavez, E. L. (1998). Structural equation socialization model of substance use among Mexican-American and White Non-Hispanic School Dropouts. *Journal of Adolescent Health*, 23, 128-138.
- Swaim, R. C., Beauvais, F., Chavez, E. L. and Oetting, E. R. (1997). The effect of school dropout rates on estimates of adolescent substance use among three racial/ethnic groups. *American Journal of Public Health*, 87, 51-55.
- Tanner, J., Davies, S. and O'Grady, B. (1999). Whatever happened to yesterday's rebels? Longitudinal effects of youth delinquency on education and employment. *Social Problems*, 46, 250-274.
- Tart, C. (1970). Marijuana intoxication: Common experiences. *Nature*, 226, 701-704.
- Tennant, F. S. and Groesbeck, C. J. (1972). Psychiatric effects of hashish. *Archives of General Psychiatry*, 33, 383-386.
- Thomas, H. (1993). Psychiatric symptoms in cannabis users. *British Journal of Psychiatry*, 163, 141-149.
- Weil, A. (1970). Adverse reactions to marihuana. *New England Journal of Medicine*, 282, 997-1000.
- Williams, P. (1997). *Progress of the National Drug Strategy: Key National Indicators*. Canberra: Commonwealth Department of Health and Family Services.

Appendix 1: A summary of the evidence on cannabis dependence, the gateway hypothesis, cognitive effects and psychosis (source: Hall and Solowij, 1998)

The "Gateway hypothesis"

A consistent finding in the USA (Newcombe and Bentler, 1988) has been the regular sequence of initiation into drug use in which cannabis use has typically preceded involvement with "harder" illicit drugs such as stimulants and opioids (Kandel, 1988). The interpretation of this sequence remains controversial. The least compelling hypothesis is the hypothesis that cannabis use directly increases the use of later drugs in the sequence. There is better support for two other hypotheses: (1) that nonconforming adolescents who have a propensity to use other illicit drugs are more likely to be recruited into using cannabis; and (2) that once recruited to cannabis use, social interaction with drug using peers, and greater access to illicit drug markets, increases the likelihood of their using other illicit drugs (Fergusson and Horwood, 1997; Kandel, 1988).

A dependence syndrome

Animals develop tolerance to the effects of repeated doses of THC (Adams and Martin, 1996). Some heavy cannabis smokers also develop tolerance to its subjective and cardiovascular effects (Compton et al, 1990) and some users report withdrawal symptoms on the abrupt cessation of cannabis use (Compton et al, 1990; Weisbeck et al, 1996).

There is evidence that a cannabis dependence syndrome occurs in heavy, chronic users of cannabis (Hall et al, 1994). These users report problems in controlling their cannabis use and continue to use despite experiencing adverse personal consequences of use (Kandel and Davies, 1992; Stephens and Roffman, 1993a, 1993b; Swift et al, 1998a, 1998b). There is clinical evidence that there is a cannabis dependence syndrome analogous to that for alcohol (Hall et al, 1994). In the USA, cannabis dependence is among the most common form of illicit drug dependence in the population (Anthony et al, 1994).

In the USA National Comorbidity Survey the risk of becoming dependent on cannabis among those who ever use (9%) was more like the equivalent risk for alcohol (15%) than it was for nicotine (32%) or opioids (23%) (Anthony et al, 1994). The risk is higher, between a third and a half, among persons who use cannabis daily for weeks to months (Hall et al, 1994).

Cognitive effects

The long term heavy use of cannabis does not produce severe or grossly debilitating impairment of cognitive function that is comparable to the impairments found in chronic heavy alcohol drinkers (Block, 1996; Lyketsos et al, 1999). There is evidence that it may produce more subtle impairment of memory, attention and organisation, and the integration of complex information (Fletcher et al, 1996; Pope and Yurgelun-Todd, 1996; Solowij, 1998). The longer cannabis has been used, the more pronounced the cognitive impairment appears to be (Solowij, 1998). These impairments are subtle so it remains to be determined how significant they are for everyday functioning, and whether they are reversed after an extended period of abstinence.

Early studies which suggested that heavy cannabis use caused gross structural brain damage have not been supported by better controlled studies using more sophisticated methods (Solowij, 1998). Recent animal research has shown that chronic cannabinoid administration may compromise the endogenous cannabinoid system (Adams and Martin, 1996). These results are consistent with the subtlety of the cognitive effects of chronic cannabis use in humans.

Psychosis

Large doses of THC have been reported to produce confusion, amnesia, delusions, hallucinations, anxiety, and agitation (Chopra and Smith, 1974). Such reactions are rare, occurring after unusually heavy cannabis use, and remitting rapidly after abstinence from cannabis (Hall et al, 1994).

There is an association between cannabis use and schizophrenia. A prospective study of 50,000 Swedish conscripts (Andreasson et al, 1987) found a dose-response relationship between the frequency of cannabis use by age 18 and the risk of a diagnosis of schizophrenia over the subsequent 15 years. This suggests that chronic cannabis use may precipitate schizophrenia in vulnerable individuals (Andreasson et al, 1987).

It is biologically plausible that cannabis use can exacerbate the symptoms of schizophrenia (Hall et al, 1994) and there is prospective evidence that continued cannabis use predicts more psychotic symptoms in persons with schizophrenia (Linszen et al, 1994). A declining incidence of treated cases of schizophrenia over the period when cannabis use has increased makes it unlikely, however, that cannabis use has caused cases of schizophrenia that would not otherwise have occurred (Der, Gupta and Murray, 1990).

References for Appendix 1

- Adams, I.B. and Martin, B.R. Cannabis: pharmacology and toxicology in animals and humans. *Addiction* 1996; 91: 1585-1614.
- Andreasson, S., Allebeck, P., Engstrom, A., Rydberg, U. Cannabis and schizophrenia: A longitudinal study of Swedish conscripts. *Lancet* 1987; 2: 1483-1486.
- Anthony, J.C., Warner, L.A., Kessler, R.C. Comparative epidemiology of dependence on tobacco, alcohol, controlled substances and inhalants: basic findings from the National Comorbidity Study. *Clin Exper Psychopharm* 1994; 2: 244-268.
- Block, R.I. Does heavy marijuana use impair human cognition and brain function? *JAMA* 1996; 275: 560-561.
- Chopra, G.S., Smith, J.W. (1974). Psychotic reactions following cannabis use in East Indians. *Arch General Psychiat* 1974; 30: 24-27.
- Compton, D.R., Dewey, W.L., Martin, B.R. Cannabis dependence and tolerance production. *Adv in Alcoh Subst Abuse* 1990; 9: 128-147.
- Der, G., Gupta, S., Murray, R.M. Is schizophrenia disappearing? *Lancet*, 1990; 1: 513-516.
- Fergusson D, Horwood, J. Early onset cannabis use and psychosocial adjustment in young adults. *Addiction* 1997; 92: 279-296.
- Fletcher, J.M., Page, J.B., Francis DJ, et al. Cognitive correlates of long-term cannabis use in Costa Rican men. *Arch Gen Psychiat* 1996; 53: 1051-1057.
- Hall, W., Solowij, N., Lemon, J. *The Health and Psychological Effects of Cannabis Use*. National Drug Strategy Monograph Series No. 25. Australian Government Publication Service, Canberra, 1994.
- Kandel DB. Issues of sequencing of adolescent drug use and other problem behaviors. *Drugs & Society* 1988: 3: 55-76.
- Kandel, D.B. and Davies, M. (1992) Progression to regular marijuana involvement: Phenomenology and risk factors for near daily use. In M. Glantz and R. Pickens (Eds) *Vulnerability to Drug Abuse*. American Psychological Association, Washington.
- Lyketsos, C.G., Garrett, E., Liang, K.Y., and Anthony, J.C. (1999) Cannabis use and cognitive decline in persons under 65 years of age. *American Journal of Epidemiology*, 149, 794-800.
- Linszen, D.H., Dingemans, P.M., Lenior, M.E. Cannabis abuse and the course of recent-onset schizophrenic disorders. *Arch Gen Psychiat* 1994; 51: 273-279.
- Newcombe T, Bentler P. *Consequences of Adolescent Drug Use: Impact on the Lives of Young Adults*. Sage Publications, Newbury Park, California, 1988.

Pope, H.G., Yurgelun-Todd, D. The residual cognitive effects of heavy marijuana use. *JAMA* 1996; 275: 521-527.

Solowij, N. *Cannabis and Cognitive Functioning*. Cambridge University Press, Cambridge, 1998.

Stephens, R.S., Roffman, R.A., Simpson, E.E. Adult marijuana users seeking treatment. *J Consult Clin Psychol* 1993a; 61, 1110-1104.

Stephens, R.S. and Roffman, R.A. (1993b) Adult marijuana dependence. In J.S. Baer, G.A. Marlatt, and R.J. MacMahon (Eds) *Addictive Behaviors Across the Lifespan: Prevention, Treatment and Policy Issues*. Newbury Park, California: Sage Publications.

Swift, W., Hall, W., Didcott, P. and Reilly, D. (1998a) Patterns and correlates of cannabis dependence among long-term users in an Australian rural area. *Addiction*, 93, 1149-1160.

Swift, W., Hall, W. and Copeland, J. (1998b) Characteristics of long-term cannabis users in Sydney, Australia. *European Addiction Research*, 4, 190-197.

Weisbeck, G.A., Schuckit, M.A., Kalmijn, J.A. et al. An evaluation of the history of marijuana withdrawal syndrome in a large population. *Addiction*, 1996; 91: 1469-1478.

Appendix 2: A summary of the evidence on the potency of cannabis

(source: Hall and Swift, 1999)

A number of commentators in the alcohol and other drugs field have recently claimed that the THC content of cannabis used in Australia has increased between 10 and 30 times over the past two decades. This has raised understandable queries about its role in a possible increase in the adverse health and psychological effects of cannabis use experienced by young people.

There is a need to distinguish two different interpretations of this claim: (i) that the average THC content of cannabis plants has increased, and (ii) that the average THC content of cannabis products as consumed by Australian users has increased by 10-30 times. We examine evidence on each claim and discuss the implications for harm.

Has the average THC content of cannabis plants increased?

The THC content of Australian cannabis products has not been systematically tested by any Australian police force over the period in which average THC content has been claimed to have increased, as there is no legislative reason for doing so. There is therefore no Australian data to support the claim that there has been a 10 to 30-fold increase in average THC content of cannabis in Australia.

The USA is the only country that has regularly collected data on the THC content of cannabis plants over the past several decades. Claims that this data indicated that the THC content of marijuana in the USA had increased between three to seven-fold from the early 1970s to the mid 1980s have been challenged by data from independent laboratories, and because such claims relied on the assumption that the samples from the middle 1970s were representative of cannabis consumed at that time. More recent data have failed to show a 10-30 fold increase in the THC content of seizures between 1984 and 1998. At most this series shows a small increase in THC content from 3.3% in 1980 to 4.4% in 1998.

The New Zealand government has also intermittently tested the THC content of cannabis samples over the past two decades. Samples of hydroponically grown cannabis tested in a NZ survey typically contained 6-8% THC, with an occasionally higher sample.

There are two more plausible alternative explanations for an upsurge in anecdotally reported adverse effects of cannabis use: changing cannabis markets have increased the availability of more potent forms of cannabis; and there have been changes in the patterns of cannabis use among Australian cannabis users that increase the prevalence of harmful use.

Changing cannabis markets

Over the past two decades a large scale illicit cannabis industry has developed in Australia to meet the demand for cannabis products among a growing number of cannabis users. It has been estimated that daily and weekly cannabis users, who prefer the more potent forms of cannabis, account for 80% of cannabis consumed. Any increase in the number of regular cannabis users that may have occurred in recent decades may have increased the demand for and availability of more potent forms of cannabis. Any such increase in the availability of more potent forms of cannabis would have increased the amount of THC consumed by heavier cannabis users without there having been any increase in the average THC content of cannabis plants.

It is also a plausible hypothesis that the supply of more potent cannabis products has been encouraged by the success of domestic law enforcement in detecting and destroying large-scale cannabis plantations, creating an incentive for illicit suppliers of cannabis to grow small numbers of cannabis plants with a higher THC content (e.g., hydroponic cultivation).

Changing patterns of cannabis use

Survey data suggest that in the 1990s young Australians have probably initiated cannabis use at an earlier age than was the case in the 1980s. The lifetime prevalence of cannabis use in Australia and the United States, particularly among adolescents, has increased, after a decline in the 1980s and early 1990s. Earlier initiation of cannabis use increases the chances that users will become daily or nearly daily cannabis users, and increases the likelihood that they will become dependent on cannabis and experience adverse personal and social consequences as a result of their use. Regular cannabis use makes users tolerant to the effects of THC, encouraging the use of more potent cannabis preparations and the use of waterpipes or "bongs" in the belief that it maximises the delivery of THC. Population based data reveal that "heads" are the most commonly used form of cannabis in Australia, while cannabis is most frequently smoked in waterpipes or "bongs".

All these changes in patterns of use – earlier initiation of cannabis use, more regular use of more potent cannabis products and greater use of waterpipes – have probably played a greater role in increasing the amount of THC consumed by regular cannabis users than any increase in the average THC content of cannabis plants. And it is these patterns of use that may explain apparent increases in numbers of adolescents and young adults experiencing problems with their cannabis use.

What are the health implications of any increase in THC content?

A major concern raised by the claimed increase in the THC content of cannabis has been that it will increase the adverse health and psychological risks of cannabis. Research suggests that unlike nicotine smokers, cannabis users have only a limited ability to titrate their dose. In this case, the effect of using more potent cannabis products will depend upon the type of health effect in question, and the user's experience with cannabis. Higher average doses of THC will probably increase the risk of adverse psychological effects of cannabis use, an effect likely to be most obvious among naive or first time cannabis users. This effect may discourage further experimentation with the drug among these users. Risks of increased THC exposure among regular cannabis users are less certain. They possibly include an increased risk of accidents among those who drive while intoxicated, especially if cannabis use is combined with alcohol, and an increased risk of regular cannabis users developing dependence. If the THC content of the most commonly used Australian cannabis products has increased, the net adverse effects of cannabis use may have marginally increased. Respiratory risks may be marginally decreased if cannabis smokers are able to titrate their doses of THC.

9

Explanations of the association between cannabis use and early school leaving

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