

## RESEARCH REPORT ON CANNABIS

# A longitudinal study of cannabis use and mental health from adolescence to early adulthood

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### Abstract

**Aims.** To examine the longitudinal association between cannabis use and mental health. **Design.** Information concerning cannabis use and mental health from 15 to 21 years was available for a large sample of individuals as part of a longitudinal study from childhood to adulthood. **Participants.** Participants were enrolled in the Dunedin Multidisciplinary Health and Development Study, a research programme on the health, development and behaviour of a large group of New Zealanders born between 1 April 1972 and 31 March 1973. **Measurements.** Cannabis use and identification of mental disorder was based upon self-report as part of a general assessment of mental health using a standard diagnostic interview. Daily smoking and alcohol use at age 15 were assessed by self-report. Indices of family socio-economic status, family climate and parent-child interaction were formed using information gathered from parent report and behavioural observations over early childhood. Childhood behaviour problems were assessed by parent and teacher report. Attachment to parents was assessed in adolescence. **Findings.** Cross-sectional associations between cannabis use and mental disorder were significant at all three ages. Both outcome variables shared similar pathways of low socio-economic status and history of behaviour problems in childhood, and low parental attachment in adolescence. Mental disorder at age 15 led to a small but significantly elevated risk of cannabis use at age 18; by contrast, cannabis use at age 18 elevated the risk of mental disorder at age 21. The latter association reflected the extent to which cannabis dependence and other externalizing disorders at age 21 were predicted by earlier level of involvement with cannabis. **Conclusions.** The findings suggest that the primary causal direction leads from mental disorder to cannabis use among adolescents and the reverse in early adulthood. Both alcohol use and cigarette smoking had independent associations with later mental health disorder.

### Introduction

Longitudinal studies from the United States and Canada of the natural history of drug use suggest

that the major period for onset of cannabis use occurs before age 20 years, with the peak of onset occurring around 16–18 years (Chen &

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Kandel, 1995; De Wit *et al.*, 1997). Thereafter, cannabis use commences a decline in the early 20s, although early onset of use may delay the time to cessation of use of the drug (De Wit *et al.*, 1997). In New Zealand (NZ) the use of cannabis is relatively common among young people, with a similar pattern of rapid onset at about age 18. Evidence from the Dunedin Multi-disciplinary Health and Development Study (DMHDS), a longitudinal study of health across the life-span, has suggested that about 15% of young NZ 15-year-olds have used cannabis in the last year (McGee & Feehan, 1993), rising to 43% at age 18 and 52% by age 21 (Poulton *et al.*, 1997). Fergusson & Horwood (1997) have reported a similar accelerating pattern of cannabis use among adolescents enrolled in the Christchurch (NZ) Health and Development Study.

Use of cannabis among young people has been associated with co-morbid or concurrent mental health problems both in cross-sectional (Deykin, Levy & Wells, 1986) and longitudinal studies (Johnson & Kaplan, 1990; Miller-Johnson *et al.*, 1998). While most of those using cannabis do not progress to cannabis dependence, rates of co-morbidity with other mental health disorders may be relatively high (Weinberg *et al.*, 1998). For example, a cross-sectional study of those 46 adolescents reporting more frequent cannabis use at age 15 years in the DMHDS (top 5% of the sample) suggested that 43 had a concurrent mental health disorder. Most typically, this was non-aggressive conduct disorder typified by an associated pattern of alcohol use, and truanting, running away from home, persistent lying or non-confrontational stealing. Deykin *et al.* (1986), in a cross-sectional study of 16–19-year-olds, reported that those with cannabis dependence were about three times more likely than those without to report a history of major depressive disorder.

In the latter study, participants reported that the depression often preceded the substance use, raising the question of the nature of the relationship between cannabis use and mental health problems; in other words, “what leads to what?” The answer to this relatively straightforward question is by no means simple. As Fergusson & Horwood (1997) have noted, there are three possible ways of accounting for the relationship between cannabis use and mental health prob-

lems. First, the two may be associated because they share common risk factors such as family or individual characteristics; their relationship may be non-causal but simply reflective of overlapping aetiologies for the two distinct outcomes. A second possibility is that individuals who show mental health problems are more predisposed towards using cannabis either through self-medication, as suggested by Deykin *et al.* (1986), or through a differential association with a sub-culture that uses drugs. There is evidence for both paths to use. For example, Henry *et al.* (1993) found that cannabis use among 15-year-old boys from the DMHDS was predicted by both earlier anti-social behaviour and depression in the pre-adolescent years. By contrast, use among girls at this age was strongly related to concurrent antisocial behaviour rather than earlier mental health in pre-adolescence, suggesting that the determinants of early cannabis use might be different for males and females. Johnson & Kaplan (1990) reported that cannabis use, and particularly daily use, was predicted by earlier mental health problems as a way of coping with stress, while Miller-Johnson *et al.* (1998) found that conduct problems in the 6th grade, but not depression, predicted cannabis use by the 10th grade.

The third possibility is that cannabis use, irrespective of its initial determinants, brings about its own harmful consequences by increasing psychological symptoms, either through direct effects on physiological functioning (Brook, Cohen & Brook, 1998) or related effects on interpersonal and role functioning (Fergusson & Horwood, 1997). These consequences may occur in both the short- and long term. Luthar & Cushing (1997) found evidence that, among 15-year-olds, cannabis use at the beginning of the year was associated with increased self-report of depression and anxiety 6 months later; conversely, earlier adjustment difficulties did not predict later use. In their longitudinal study of adolescents from the Christchurch Health and Development Study, Fergusson & Horwood (1997) found that early cannabis use around age 15–16 years was predictive of later dependence, anti-social offending, poorer mental health and reduced life opportunities at age 18 years. These effects of early use were substantially reduced but not eliminated when controlling for likely shared aetiological factors such as family disad-

vantage. Brook *et al.* (1998), in a longitudinal study of substance use and psychiatric disorder, have reported that prior cannabis use in adolescence was predictive of later antisocial personality disorder in early adulthood.

Taken together, what evidence there is suggests that all three possibilities outlined above have some validity. Cannabis use and mental health do appear to share similar aetiological factors, but these may not fully explain the nature of the relationship between the two. There is some evidence to suggest that early mental health problems are predictive of later use, although this relationship may be stronger from pre-adolescence to adolescence (Henry *et al.*, 1993) than at later ages (Brook *et al.*, 1998). Further, earlier use in adolescence may not be without risk of later mental health problems, although the relative size of these consequences in comparison with those of other substances is more difficult to gauge, particularly where comorbidity among substances used may be high. In this study, we present the findings relating to cannabis use and mental health from ages 15–21 years using data from the DMHDS. While some findings from the DMHDS on cannabis use and mental health have already been published, most have been cross-sectional in nature. The Henry *et al.* (1993) study from pre-adolescence to adolescence is the only one to have examined the longitudinal relationship between these two outcomes. The present study extends this analysis from adolescence to early adulthood, and provides a replication and extension of the findings from the Christchurch Child Development Study (see also Fergusson, 1997).

## Methods

### Sample

The participants were enrolled in the Dunedin Multidisciplinary Health and Development Study (DMHDS), a longitudinal investigation of the health, development and behaviour of a large sample of NZ children being followed from birth across the life-span. The children were part of a cohort born between 1 April 1972 and 31 March 1973 (Silva & McCann, 1996). They were first enrolled in the study at age 3; of the 1139 eligible, 1037 were assessed at that age. Subsequent assessments occurred every 2 years thereafter until age 15 and then at ages 18, 21 and most recently 26 years (1998–99). The sam-

ple is slightly socio-economically advantaged compared with the remainder of NZ, and is under-representative of Maori and Pacific Islands people. By and large, however, it is comparable to those from other English-speaking western cultures.

### Measures

*Cannabis use from ages 15 to 21 years.* Cannabis use was first assessed by self-report at age 13 as part of a broader study of delinquency (Moffitt & Silva, 1988). However, there was very little reported use at that age with only 1.0% of the sample reporting any use in the previous year. Cannabis use was subsequently assessed at age 15 as part of the delinquency assessment; sample members were asked how often they had used cannabis in the past year, with response categories “never”, “once or twice” or “three or more times”. At ages 18 and 21 years, two measures relating to cannabis use in the past year were obtained. The first was a measure of frequency of cannabis use based on number of occasions obtained as part of the assessment of illegal activities. The second measure was gathered as part of a mental health interview, using the Diagnostic Interview Schedule or DIS (Robins *et al.*, 1989) which provided for identification of cannabis dependence over the past year according to DSM-III-R criteria.

*Mental disorders at ages 15, 18 and 21 years.* At age 15, the sample members were interviewed using the Diagnostic Interview Schedule for Children or DISC-C (Costello *et al.*, 1982), which provided for identification of mental health disorders over the past year according to DSM-III criteria. The mental health disorders so identified were attention deficit disorder with or without hyperactivity, conduct and oppositional disorders, anxiety disorders and depressive disorders. Parents completed the Revised Behavior Problem Checklist (RBPC) of Quay & Peterson (1987). Full details concerning the identification of mental health disorders at this age are provided by McGee *et al.* (1990). At ages 18 and 21 years, mental health was assessed using the DIS, thereby allowing for the identification of DSM-III-R diagnoses of anxiety and depressive disorders, alcohol dependence, other substance dependence and antisocial personality disorder. The procedures and results of these two assess-

ments are provided by Feehan *et al.* (1994) and Newman *et al.* (1996), respectively.

*Smoking and alcohol use at age 15 and 18 years.* Smoking and alcohol use among members of the Dunedin sample are both correlated with their cannabis use (Stanton, 1996). So these two variables were included in the present study particularly in view of their relationship with mental health (Brook *et al.*, 1998). The assessment of cigarette smoking has been part of the DMHDS from age 9 years (Stanton, 1996). At age 15 and 18, each study member was interviewed about cigarette smoking and those who reported smoking daily were identified. Problematic alcohol use at age 15 was assessed by two questions from the self-report delinquency scale, namely "buying or drinking alcohol drinks" and "drinking during school hours". Response categories were the same as for cannabis use, "never", "once or twice" or "three or more times". At age 18, alcohol use was assessed as part of the DIS interview.

*Parent attachment at age 15 years.* Nada-Raja, McGee & Stanton (1992) identified perceived attachment to parents as an important correlate of mental health among study members at age 15 years. Attachment was measured using a self-report questionnaire (Armsden & Greenberg, 1987) assessing aspects of the adolescent's perceived trust in (e.g. "my parents respect my feelings"), communication with (e.g. "I tell my parents about my problems and troubles") and alienation from parents (e.g. "I don't get much attention at home"). This measure was included in the present study to identify its role as a causal risk factor in cannabis use (see Fergusson & Horwood, 1997). A score of 23 or less on the parent scale was used to identify low levels of attachment.

*Family background measures.* The evidence reviewed in the introduction to this paper suggested that family disadvantage is predictive of both mental health problems and cannabis use. For this reason it was considered important to control for family background in examining the nature of the relationship between these two variables. McGee & Williams (1998) have developed three summary indices to describe the study members' home environments from ages 3 to 9 years. These were: (1) socio-economic dis-

advantage characterized by low socio-economic status, young mother at age of first pregnancy, low level of maternal education and single parenting; (2) family climate characterized by parental separation, low within-family social support and maternal depression; and (3) parent-child interaction characterized by maternal rejection, low egalitarianism, high authoritarianism and lax-inconsistent discipline. A cut-off score of 2 or more on each index was used to identify disadvantage in each of these three domains of family life.

*Behaviour problems in childhood.* The presence of significant levels of problem behaviour in childhood may also constitute a common pathway to later mental disorder and cannabis use in adolescence. Consequently, such behaviour problems were included as predictors of outcome in the present study. From ages 5 to 9 years, parents and teachers completed the Rutter *et al.* (1970) Child Scales A and B, respectively, providing reports on a variety of behavioural and emotional problems. Recommended cut-off scores were used to identify children showing persistently high levels of problems over time and/or pervasive problems reported by both parents and teachers (McGee, Feehan & Williams, 1996).

#### *Statistical analyses*

The data were analysed using STATA (Stata-Corp, 1997). The results are presented in five main sections. First we examine the cross-sectional relationship between cannabis use and mental health disorder at each of the three ages. Secondly, odds ratios (ORs) were computed to examine the relationship between childhood family background and early behaviour problems and both cannabis use and mental disorder at age 15 years. The third phase of the analysis examined the predictive relationship between cannabis use and mental disorder from age 15 to 18 years. The fourth phase examined cannabis use and mental disorder from 18 to 21 years. Finally, we examined the possible influences of missing data on the conclusions.

The analyses primarily involved bivariate logistic regression as a way of examining the effects of risk factors (independent variables) on the two different outcomes, cannabis use and mental disorder (Fitzmaurice *et al.*, 1995). Bivariate logistic

regression allows for two outcomes to be modelled simultaneously in a single model, rather than developing two separate models of cannabis use and mental disorder. In effect, it is equivalent to a test of the difference between two sets of regression coefficients, one for cannabis use and one for mental disorder. Consequently it is possible to identify both shared and unique risk factors for these two outcome. In the model, prior risk factors at one age are entered as independent variables together with an indicator variable for outcome and interactions between the various risk factors and outcomes at the subsequent age. The findings are presented as univariate unadjusted ORs and as ORs adjusted for other terms in the model. The results of the bivariate models are presented as adjusted ORs together with their 95% confidence intervals using robust standard errors. Chi-square tests were used to compare those for whom complete data were available with the remainder of the sample.

The bivariate analyses described above provide predictive models allowing an exploration of the relationships between "any cannabis use" and "any mental disorder" from ages 15–18 years and 18–21 years. We also conducted subsidiary analyses to examine the relationships between type of mental health disorder and frequency of cannabis use across these ages. However, it should be recognized that these analyses are somewhat less powerful than the bivariate analyses when looking at types of mental disorder and the relationship with cannabis use. Furthermore, these analyses are somewhat constrained in their interpretation because of the relatively marked degree of co-morbidity among mental disorders, particularly at ages 18 and 21 years (Feehan *et al.*, 1994; Newman *et al.*, 1996). In the case of the frequency of cannabis use, the data at ages 18 and 21 years indicated that reports of cannabis use in the last year were heaped around particular values (e.g. 12 indicating use once per month; 52 indicating use once a week; and 365 indicating daily use). Consequently, we were unable to use this frequency data as a continuous variable. Rather, we identified four categories of cannabis use at 18 and 21 years: no reported use in the last year; use less than once per month; use at least monthly but less than once per week; and use at least once per week. Previous research has also converted frequency data to categorical data in this way (Fergusson & Horwood, 1997).

## Results

### *The association between cannabis use and mental health*

Table 1 shows the extent of any self-reported cannabis use in the last year for those identified with and without a mental health disorder at ages 15, 18 and 21 years. The cross-sectional association between use and disorder was significant at all three ages ( $p < 0.05$ ). Inspection of the table indicates a rapidly accelerating pattern of cannabis use over the three ages both among those with and without disorder. *Post-hoc* comparisons were made among broader diagnostic groups to identify those with higher use. At age 15, in comparison with those adolescents with no disorder (8.6%), cannabis use was significantly higher among those with conduct or oppositional disorder (65.4%) and to a lesser extent anxiety/depressive disorders (19.1%), but not among those showing attention deficit disorder (6.3%). At age 18 years, cannabis use was significantly higher among those with alcohol and/or cannabis dependence (82.9%) and conduct disorder in the absence of dependence (80.0%), but not anxiety/depressive disorders (42.5%). Finally, at age 21 the pattern of cannabis use was similar to that at 18, being higher among those with any dependency (87.7%) but not anxiety/depressive disorder (53.7%). There were only 13 individuals with antisocial personality disorder not co-morbid with dependency; 10 reported use of cannabis. Overall, these descriptive findings suggest higher rates of cannabis use among those with mental health disorders from age 15 onwards, with accompanying patterns of accelerating use from 15 to 21 years, occurring in the context of increases in rates of mental disorder from 15 to 21 years.

### *Childhood family background, behaviour problems, cannabis use and mental health*

Table 2 shows the background characteristics of those reporting using cannabis at age 15 and those reporting no use. Univariate associations by  $\chi^2$  test are shown in the table indicating that socio-economic disadvantage in childhood and low parent attachment in adolescence were associated with cannabis use. Both daily smoking and alcohol use were also strongly associated with cannabis use at this age. Table 3 shows the nature of the predictive relationship between the family background indices reflecting low SES, conflictual family climate and poor parent-child

**Table 1.** *Self-reported cannabis use among those with and without a mental disorder at ages 15, 18 and 21 years*

	Age (years)		
	15 (N = 940)	18 (N = 929)	21 (N = 948)
Any mental disorder (N)	36.2% (207)	59.1% (340)	68.1% (386)
No mental disorder (N)	8.6% (733)	34.1% (589)	41.6% (562)

interaction, behaviour problems in childhood and the two outcomes of any cannabis use and any mental health disorder at age 15. Gender was also included as a predictor. The results from the bivariate logistic regression suggest that both outcomes were significantly associated with being female, coming from a family background which was socio-economically disadvantaged, and having a history of early problem behaviour. These variables were common to both cannabis use and mental disorder at age 15; there were no unique predictors of either outcome. When the adolescent variables of low parental attachment, smoking and alcohol were included in the model, these earlier childhood associations were no longer significant.

#### *Cannabis use and mental health from age 15 to 18 years*

Table 4 shows the relationship between age 15 variables including cannabis use and mental disorder, and outcome at age 18 years for the 891 individuals with complete data. Results from the bivariate logistic regression suggest that each outcome at age 18 was a mixture of specific and shared predictors at age 15. Mental health at age 18 was predicted by being female, having an earlier mental health disorder and by daily smoking, alcohol use and low levels of parental attachment at age 15. Significantly, cannabis use at age 15 did not predict mental health problems at age 18 years. By contrast, cannabis use at age 18 was predicted by being male, cannabis use at age 15 and, to a lesser extent but significantly, having a mental disorder at age 15. Smoking, alcohol use and low parental attachment similarly predicted later cannabis use. The variables for family background and early behaviour problems were included in the bivariate model, but none of these

showed significant relationships with either outcome once the age 15 variables were included. For this reason, Table 4 shows only those variables from age 15 years.

The above findings suggested a small but significant elevation in risk of cannabis use at age 18, among those with a mental health disorder at age 15. Table 5 shows frequency of cannabis use at age 18 (no reported use; < monthly; < weekly; and weekly use) as a function of both cannabis use and type of mental health disorder at age 15 years. The latter has been categorized as no disorder, internalizing disorder only (anxiety and depressive disorders) and externalizing disorders (conduct, oppositional and attention deficit-hyperactivity disorders), although externalizing disorders may be co-morbid with an internalizing disorder. Modelling of this data using multiple logistic regression indicated that, after controlling for cannabis use at age 15, those with an externalizing disorder were more likely to report cannabis use at age 18, particularly use at least monthly (OR = 2.84) or weekly (OR = 6.40), compared to those without a mental health disorder at age 15.

We also modelled the pathway from cannabis use at age 15 to mental disorder at age 18 years, where the latter was categorized as no disorder; internalizing disorder; externalizing disorder (alcohol dependence/conduct disorder); and cannabis dependence. Again, it should be noted that these are not pure diagnostic groups; those with an externalizing disorder may well have had a co-morbid internalizing disorder (but not cannabis dependence), while those with cannabis dependence may have had any of the other types of disorder. This analysis indicated that after controlling for concurrent mental health cannabis use at age 15 years did not predict, to any significant extent, later internalizing disorder

**Table 2.** *Childhood and adolescent background characteristics of those reporting using cannabis at age 15 years and those reporting no use*

Characteristic	Cannabis use ( <i>N</i> = 143)	Non-use ( <i>N</i> = 801)	$\chi^2$ (1df)
Female	52.5%	47.8%	1.04
Low SES	51.0%	33.8%	15.53*
Conflictual family climate	50.4%	41.8%	3.60
Poor parent-child interaction	38.5%	37.8%	< 1.00
History of behaviour problems	28.7%	23.5%	1.79
Low parent attachment: 15	34.6%	11.7%	47.31*
Daily smoking: 15	55.2%	7.5%	219.08*
Drinks alcohol: 15	70.6%	19.4%	161.43*

\*  $p < 0.05$ , otherwise non-significant.

(OR = 1.21), externalizing disorder (OR = 0.84) or cannabis dependence (OR = 1.45) at age 18 years.

#### *Cannabis use and mental health from ages 18 to 21 years*

Table 6 shows the relationship between the cannabis and mental health variables from age 18 to age 21, for the 871 with available data. Once again, the bivariate logistic regression suggested that earlier smoking and alcohol use were common predictors of both later cannabis use and mental disorder. Cannabis use at age 21 was strongly related to being male, while mental disorder was more common among females. Mental disorder at age 18 was significantly related to mental disorder at age 21 years, but was not predictive of later cannabis use at that age. Cannabis use at the earlier age was highly predictive of later use. Among males but not females, cannabis use at age 18 predicted mental disorder at age 21 years. This was indicated in the model by a significant gender  $\times$  cannabis use interaction with mental disorder at age 21 as the outcome (OR for males = 2.00; for females, OR = 0.75).

The model shown in Table 6 indicated that there was no significant pathway from mental health at age 18 to cannabis use at age 21 years. Further analysis indicated that later level of cannabis use was unrelated to presence of either an internalizing or externalizing disorder at the earlier age, after controlling for earlier level of cannabis use.

However, the overall model suggested an elev-

ated risk of later mental disorder among males using cannabis at age 18. One possibility is that this relationship simply reflects the increased risk of cannabis dependence at age 21 among those males using cannabis at the earlier age, many of whom may already have been dependent. In order to explore this finding further, we examined the relationship among males between frequency of cannabis use at age 18 (no reported use; < monthly; < weekly; and weekly use) and mental health outcome at age 21 years, categorized as no disorder; internalizing disorder; externalizing disorder (alcohol dependence/antisocial personality disorder); and cannabis dependence. We excluded from this analysis those men who were already cannabis-dependent at age 18. There were 30 such men; 27 of them had a mental disorder at age 21 years (18 were diagnosed with cannabis dependence either alone or in combination with alcohol dependence, six with alcohol dependence and three with anxiety or depressive disorders). Frequency of cannabis use at age 18 predicted cannabis dependence at age 21 years in a linear fashion (OR = 1.85 for each category of use compared with the preceding category). Furthermore, it also predicted externalizing disorder at age 21, even after controlling for other mental health disorders at age 18 (OR = 1.56 for each ascending category of cannabis use). However, there was no significant relationship between frequency of cannabis use at age 18 and diagnosis of internalizing disorder at age 21 years.

It was possible to compare the elevated risk of mental disorder at age 21 years associated with

**Table 3.** Childhood predictors of cannabis use and mental disorder at age 15

Predictor	Univariate ORs*		Adjusted ORs		Bivariate model ORs
	Mental disorder	Cannabis use	Mental disorder	Cannabis use	
Gender (male)	0.66	0.83	0.56	0.79	0.66 (0.50-0.87)
History behaviour problems	1.98	1.31	2.13	1.22	1.66 (1.24-2.24)
Socio-economic disadvantage	2.07	1.87	1.94	1.77	1.85 (1.27-2.70)
Conflictual family climate	1.25	1.41	0.93	1.28	1.07 (0.82-1.41)
Poor parent-child interaction	1.23	1.03	1.08	0.92	1.00 (0.76-1.33)

\* Values shown are odds ratios; adjusted ORs are adjusted for other terms in the model. Values in parentheses show 95% confidence intervals for bivariate ORs.

earlier cannabis use, and the elevated risks associated with earlier smoking and alcohol use. Alcohol use at age 18 years elevated the risk for both later alcohol and cannabis dependence, but not anxiety/depressive disorder at age 21 years. Daily smoking at age 18 years elevated the risk of anxiety/depressive disorder and alcohol dependence, but not later cannabis dependence.

*Missing values*

It was not possible to include all individuals in the regression models from 15-18 years and from 18-21 years owing to missing data on some variables. For the first model, we compared those with available data and those with missing data on gender, cannabis use, cigarette smoking, alcohol use, mental disorder and parental attachment at age 15 years. There were no statistically significant differences between the two groups on any of these measures, suggesting that those with missing data had similar levels of prior substance use and mental health to those with available data. Comparison of those with available and missing data for the 18-21-years model, however, indicated that those with missing data were significantly more likely to report daily cigarette smoking at age 18 (48.5% vs. 30.0%), but were less likely to report use of alcohol at that age (64.6% vs. 80.4%). There was no significant difference in reported use of cannabis (43.7% vs. 43.4%). They did not differ on the remaining variables. Overall, these findings suggest that those with missing data were no more

likely to report substance use than those with available data.

**Discussion**

The aim of this paper was to examine the nature of the longitudinal association between cannabis use and mental health. The descriptive epidemiology of both cannabis use and mental disorder from the DMHDS suggested a parallel course for these two important health outcomes in adolescence and early adulthood. First, the results indicated an accelerating pattern of cannabis use from ages 13 to 21 years, from virtually no reported use at age 13 to 12-month prevalence of use by age 21 of one in every two individuals (Poulton *et al.*, 1997). There was a marked increase in reported use from ages 15 to 18 years, and increasing consistency of use from 15 to 18 and more so from 18 to 21 years. These developmental increases in cannabis use occurred among those both with and without identified mental disorders, as shown in Table 1 in this paper. At the same time, there was an increase in the prevalence of mental health disorders over these years. Elsewhere, we have suggested that these increases in both the prevalence of mental disorders and their persistence over time reflect important transitions from school to higher education, work or unemployment; from living with parents at home to forming strong relationships outside the home; and for some individuals becoming parents themselves (Feehan *et al.*, 1995).

There were clearly strong cross-sectional rela-



**Table 4.** Results from bivariate logistic regression for cannabis use and mental health from ages 15 to 18 years

Predictor	Outcome at age 18 years					
	Univariate ORs*		Adjusted ORs		Bivariate model ORs	
	Mental disorder	Cannabis use	Mental disorder	Cannabis use	Mental disorder	Cannabis use
Gender (male)	0.60	1.42	0.64	1.72	0.64 (0.49–0.87)	1.71 (1.27–2.29)
Mental disorder 15	4.01	2.54	2.93	1.55	2.90 (2.00–4.21)	1.58 (1.10–2.26)
Cannabis use 15	2.69	6.45	1.11	3.07	0.97 (0.59–1.60)	3.40 (2.01–5.75)
Alcohol use 15	2.22	3.89	1.54	2.32		1.90 (0.77–1.35)
Smoking 15	2.83	4.00	1.58	1.89		1.72 (1.15–2.58)
Low parent attachment 15	2.64	2.51	1.67	1.62		1.64 (1.18–2.28)

\* Values shown are odds ratios: adjusted ORs are adjusted for other terms in the model. Values in parentheses show 95% confidence intervals for bivariate ORs.

tionships between cannabis use and disorder over these years, confirming earlier cross-sectional studies (e.g. Deykin *et al.*, 1986). The strongest relationship was evident at age 15 reflecting a pattern of relatively “non-normative” early cannabis use. Those with a mental health disorder at that age were over four times more likely to report cannabis use than those without. By contrast, as cannabis use became more the norm among the sample members and mental health disorders similarly increased in prevalence, the strength of the cross-sectional relationships at ages 18 and 21 was not quite as strong. Cannabis use was not markedly associated with anxiety/depressive disorders, but rather was elevated among those with externalizing disorders suggesting that, by and large, cannabis use may not be functioning simply as “self-medication” for anxious or depressed individuals. Many of the behaviours associated with conduct and antisocial personality disorder are illegal, as is cannabis use in NZ, suggesting that at least part of the co-morbidity we observed may reflect a willingness to contravene the law.

Fergusson & Horwood (1997), among others, have characterized the possible relationships between cannabis use and mental health as reflecting either shared common ancestry, earlier cannabis use predicting later mental disorder, or earlier mental disorder predicting later cannabis use. To date, the research findings have not

unequivocally supported any one of these possible hypotheses. What, then, do our data show? As was reported by Fergusson & Horwood (1997), our findings indicated that there was considerable overlap in the predictors of both cannabis use and mental disorder in adolescence. At least part of the early association between cannabis use and disorder reflected shared pathways from socio-economic disadvantage and behaviour problems in childhood, coupled with low attachment to parents at adolescence. Being female also predicted both early cannabis use and mental disorder, suggesting a differential pattern of uptake (see also Henry *et al.*, 1994); in the subsequent years, males reported more use and higher levels of cannabis dependence.

The results from age 15 to 18 years indicated that earlier mental health problems slightly but significantly elevated the risk of later cannabis use, particularly more frequent use. This finding is similar to that of Henry *et al.* (1994) in examining the predictive significance of pre-adolescent mental health for cannabis use at age 15 in the DMHDS. Again, externalizing disorders at age 15 years (primarily conduct disorders) predicted later cannabis use at age 18, an effect independent of cannabis use at the earlier age. A similar pattern has recently been reported by Miller-Johnston *et al.* (1998). Importantly, there was no evidence that cannabis use in adolescence

**Table 5.** Frequency of cannabis use at age 18 years as a function of cannabis use and type of mental health disorder at age 15 years

Age 15		N	Cannabis use at age 18 years			
Cannabis use	Mental disorder		No use	< Monthly	< Weekly	Weekly
No use	None	637	63.6%	25.4%	6.9%	4.1%
	Internal	84	59.5%	25.0%	10.7%	4.8%
	External	41	34.1%	29.3%	14.6%	22.0%
Use	None	62	19.4%	46.8%	12.9%	21.0%
	Internal	20	15.0%	60.0%	15.0%	10.0%
	External	47	17.0%	25.5%	12.8%	44.7%
Total		891	55.3%	27.8%	8.5%	8.4%

was associated with an increased risk of later mental health problems. By contrast, both cigarette smoking and alcohol use in adolescence independently increased the risk of later mental disorder, findings recently reported by Brook *et al.* (1998). The association between tobacco use and later mental health is of some interest and has been noted by others (Escobedo, Reddy & Giovino, 1998). Recently, Pomerlau (1997) has argued that tobacco use is becoming increasingly concentrated among individuals with various mental disorders such as depression and attention deficit disorder. Our results and those of Brook *et al.* (1998) support this association, but suggest that tobacco use may in fact lead to the disorder rather than vice versa. The mechanism underlying this association remains unclear. It may be the case that the association arises from uncontrolled confounding factors in the analysis, and a genetic basis remains a possibility.

By age 18 and 21 years, some cannabis use might almost be considered normative being reported by a large percentage of the sample, and over this same period prior mental disorders no longer predicted later cannabis use. At age 18, the earlier pattern reversed and cannabis use along with cigarette smoking and alcohol use, now elevated the risk of later mental disorder at age 21 years. Closer examination of this finding suggested that this elevated risk was confined to substance dependence and antisocial behaviour at age 21 years, and only among young men, not women. While cannabis dependence at age 18 strongly predicted later dependence, frequency of cannabis use at that age also predicted subsequent cannabis dependence in a linear fashion; the higher the level of use, the higher the risk of

later dependency. A similar but less marked linear trend was found for subsequent alcohol dependency/antisocial behaviour. Significantly, earlier cannabis use did not elevate the risk of later anxiety or depressive disorder. These findings are similar to those of Fergusson & Horwood (1997), who also reported that while earlier cannabis use increased the risk of later dependence, it did not necessarily lead to seriously increased risks of other psychosocial disorders. Alcohol use at age 18 had similar effects on subsequent risk of mental health disorders.

Overall, the present findings perhaps indicate a more limited association between early cannabis use and later mental health than has been suggested in the past. Furthermore, they suggest that examination of the association may well depend upon the stage in the individuals' development at which use occurs. Cannabis use early in adolescence might best be considered as "non-normative", reflecting the outcome of various early life experiences and sharing many of the same characteristics that are associated with mental disorder in adolescence. Among young people we would argue that the primary direction of risk lies from mental disorder to cannabis use rather than the reverse. This does not appear to reflect the use of cannabis for stress-reduction or self-medication (Johnson & Kaplan, 1990), but more a differential drift towards substance use among adolescents who show acting-out behaviours which are non-conventional in the first place. When use becomes normative in early adulthood, it acts to increase the risk of later cannabis dependence, and moderately raise the risk of alcohol dependence and antisocial behaviours.

**Table 6.** Results from bivariate logistic regression for cannabis use and mental health from ages 18 to 21 years

Predictor	Outcome at age 21 years					
	Univariate ORs*		Adjusted ORs		Bivariate model ORs	
	Mental disorder	Cannabis use	Mental disorder	Cannabis use	Mental disorder	Cannabis use
Gender (male)	0.87	1.62	0.62	1.63	0.62 (0.41–0.95)	1.61 (1.17–2.22)
Mental disorder 18	4.69	1.87	3.97	1.08	3.92 (2.87–5.35)	1.11 (0.78–1.58)
Cannabis use female 18†	1.54		0.83		0.75 (0.47–1.17)	
Cannabis use male 18†	3.59		2.21		2.00 (1.29–3.09)	
Cannabis use 18		10.67		6.68		7.27 (5.12–10.30)
Alcohol use 18	1.99	4.28	1.41	2.08	1.71 (1.26–2.31)	
Smoking 18	2.41	4.12	1.37	1.81	1.55 (1.17–2.05)	
Alcohol 15	2.21	3.59	1.46	1.85	1.62 (1.23–2.13)	

\* Values shown are odds ratios; adjusted ORs are adjusted for other terms in the model. Values in parentheses show 95% confidence intervals for bivariate ORs. †Model includes interaction effect between gender and cannabis use; reference group constitutes those of the same gender reporting non-use.

What implications do the present findings have for policy? Recently, the NZ government has held an inquiry into the mental health effects of cannabis including examination of the effects of cannabis on people's development and its possible role as a trigger for mental illness (New Zealand House of Representatives, 1998). Inquiries such as this indicate the degree of concern with which policy makers and others view the current high rates of cannabis use among young people. Our results suggest that the earlier use of cannabis (at least to age 18 years) is the outcome of socio-economic disadvantage, behaviour problems experienced in the early school years, low levels of parental attachment in adolescence and adolescent mental health problems, while at the same time reflecting broader aspects of youth culture. Prevention efforts aimed at ameliorating some of these factors may have the effect of reducing the extent of cannabis use among young people. In NZ, there is now some indication that cannabis use among 15–24-year-olds has increased a little over the last decade (Field & Casswell, 1999). Bachman, Johnston & O'Malley (1998) have argued that attempts to explain secular trends in cannabis use in the United States need to resort to explanations in

terms of trends in perceptions of risk relating to substance use and general disapproval of use. In the short term, health education to change attitudes about cannabis use among young people of school age may represent the best approach to reduction rather than greater emphasis on the longer-term mental health consequences of use for young people. On the contrary, it may well be the case that greater gains in mental health will derive from efforts to reduce the extent of tobacco and alcohol use among young people. Among older individuals, heavier users of cannabis need to be aware of the possible elevated risks for later dependence; those concerned with treatment issues probably need to be aware that the prevalence of cannabis dependence and frequent cannabis use among young adults is relatively high.

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