Louisa Degenhardt, Wayne Hall & Michael Lynskey

Cannabis use and mental health among Australian adults: Findings from the National Survey of Mental Health and Well-Being

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NATIONAL SURVEY OF MENTAL HEALTH AND WELL-BEING

This is the sixth in a series of linked NDARC Technical Reports on various aspects of the National Survey of Mental Health and Well-being (NSMHWB). This survey was a major collaborative effort between numerous Australian academics and institutions. It was funded by the Mental Health Branch of the Commonwealth Department of Health and Aged Care. Fieldwork was conducted by the Australian Bureau of Statistics in 1997. It provides the first data on the prevalence and correlates of common mental health and substance use disorders among a representative sample of more than 10,000 Australians aged 18 years and over.

Each of these Technical Reports addresses separate issues related to findings on substance use disorders among Australian adults.

The list of Technical Reports on this topic published to date are:

Hall, W., Teesson, M., Lynskey, M., & Degenhardt, L. (1998). The prevalence in the past year of substance use and ICD-10 substance use disorders in Australian adults: Findings from the National Survey of Mental Health and Well-being (Technical Report No. 63).

Swift, W., Hall, W., & Teesson, M. (1999). Cannabis use disorders among Australian adults: Results from the National Survey of Mental Health and Wellbeing (Technical Report No. 78).

Degenhardt, L., & Hall, W. (1999). The relationship between tobacco use, substance use disorders and mental disorders: Results from the National Survey of Mental Health and Well-Being (Technical Report No. 80).

Degenhardt, L., & Hall, W. (2000). The association between psychosis and problematic drug use among Australian adults: Findings from the National Survey of Mental Health and Well-Being (Technical Report No. 93).

Degenhardt, L., Hall, W., Teesson, M., & Lynskey, M. (2000). Alcohol use disorders in Australia: Findings from the National Survey of Mental Health and Well-Being (Technical Report No. 97).

Degenhardt, L., Hall, W. & Lynskey, M. (2000). Cannabis use and mental health among Australian adults: Findings from the National Survey of Mental Health and Well-Being, (Technical Report No. 98).

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EXECUTIVE SUMMARY

Surveys carried out in Australia have consistently indicated that cannabis is the most widely used illicit substance in the general population. It is therefore of considerable interest to public health to examine the patterns of association between cannabis use and the mental health and well-being of users.

There is limited clinical data on cannabis use among persons coming to the attention of mental health treatment services. Such clinical data is prone to selection biases. Some epidemiological research in the US has examined relationships between drug use disorders (of which cannabis use disorders were the most common) and other mental disorders, but there has been no examination of relationships between cannabis use and mental health in the Australian population.

The current report examined relationships between cannabis use and mental health using data from the Australian National Survey of Mental Health and Well-Being (NSMHWB). The NSMHWB provided nationally representative data on the mental and physical health of Australian persons aged 18 years and over. Unlike previous epidemiological surveys, the NSMHWB included measures of role functioning related to physical and emotional health, as well as measures of disability and psychological distress. Hence, the NSMHWB also provided an opportunity to examine the association between substance use and other indicators of psychological well-being.

The NSMHWB allowed the following questions to be answered:

1) is there an association between cannabis use, abuse and dependence, and other drug use and DSM-IV drug use disorders;
2) is there an association between cannabis use and DSM-IV affective and anxiety disorders, or with symptom measures of psychological distress and role functioning;
3) if any associations exist, are they explained by differences between cannabis users and non-users in demographic characteristics, levels of neuroticism, or in the levels of other drug use?

Around 1 in 20 persons (4.8%) reported using cannabis in the past year without meeting criteria for a DSM-IV use disorder. A further 0.8% met criteria for cannabis abuse, and 1.5% met criteria for cannabis dependence. In other words, around 300,000 adults in Australia met criteria for a DSM-IV cannabis use disorder within the past year, with another 650,000 using cannabis in a non-problematic fashion. All cannabis use was more common among males and those who were younger, with those aged 18-24 years most likely to report use, and meet criteria for abuse and dependence within the past year.

Those who reported using cannabis 5 times or less in the past 12 months ("non-users") were least likely to report alcohol use or the use of sedatives, stimulants or opiates. As involvement with cannabis use increased, so too did the prevalence of other substance use. Regular tobacco use was much more likely among cannabis users, with 20% of non-users reporting such use, compared to 50-70% of persons with some involvement with cannabis use. Similarly, cannabis use of any sort was strongly related to an increased prevalence of alcohol use disorders, with more than one in 3 of those who met criteria for either cannabis abuse or dependence (37%) also meeting criteria for an alcohol use disorder. Other drug use disorders were similarly related, with very few non-users of cannabis meeting criteria for a use disorder (0.5%), compared to one in 6 cannabis-dependent persons having another drug use disorder (18%).

There was some attenuation of the relationships between cannabis use and mental health after accounting for the effects of demographics, neuroticism, and the use of other drug types. The

association between cannabis involvement and all indicators of other substance use problems nonetheless remained highly significant. Regular tobacco use, alcohol use disorders, and other drug use disorders, were all related to involvement with cannabis independently of these other factors.

There was a strong univariate association between involvement with cannabis use in the past 12 months and the prevalence of affective and anxiety disorders. Among those with cannabis dependence, just over one in 7 met criteria for an affective disorder (14%), while 1 in 6 met criteria for an anxiety disorder (17%). In comparison, 6% of non-users met criteria for an affective disorder, and 5% met criteria for an anxiety disorder. Psychological distress and life satisfaction were also strongly related to involvement with cannabis on a univariate level. Those with increasingly higher involvement with cannabis reported greater levels of psychological distress (as measured by Kessler's Psychological Distress scale), greater limitations in the everyday lives due to emotional distress (as measured by the SF-12), and lower life satisfaction.

The correlations between cannabis involvement and affective and anxiety disorders appeared to be explained by demographics, trait neuroticism, and other drug use. It must be said however that in including neuroticism as a predictor, we may be "overcontrolling" for this trait, since reported trait levels of neuroticism may be correlated with state levels of anxiety and depression. The data also do not exclude the possibility that an indirect relationship exists, e.g. if cannabis use increased the problematic use of other drugs, which in turn increased the risks of depression and anxiety. Future research might examine this issue further, particularly longitudinal research, and prospective studies examining the effect of reducing cannabis and other drug use on depression at a later point in time.

It is still the case that heavier involvement with cannabis use is *correlated* with affective and anxiety disorders. This has important clinical implications, since comorbid anxiety and affective disorders may affect the outcome of treatment for cannabis dependence. There is a lack of literature examining this possibility. Future work needs to examine the effect of other mental health problems upon treatment for cannabis dependence, as well as investigating more comprehensive therapies for persons wishing to address their cannabis use problem.

The high rate of comorbidity needs to be kept in mind by clinicians dealing with persons with cannabis use problems. Simple screening instruments could be used to examine whether a cannabis dependent client may have other mental health issues that need addressing. Future research might involve a more comprehensive intervention targeting symptoms of depression and anxiety as well as cannabis dependence.

In the Australian adult population, persons who used cannabis were more likely to screen positively for psychosis. Around one in 143 persons who were non-users screened positively, with the prevalence increasing as involvement with cannabis increased, such that one in 15 persons who met criteria for cannabis dependence also screened positively for psychosis. After controlling for demographics, neuroticism and other drug use, the relationship between dependent cannabis use and screening positively for psychosis relationship was still significant.

In the general population, many of those with cannabis use disorders will have other mental health problems, which is important given the increase in the numbers presenting to treatment agencies for help with their dependent cannabis use. Using the NSMHWB data, it was possible to calculate that in those who met criteria for cannabis dependence, two thirds (64%) with an affective disorder sought help, compared to one fifth (21%) of those without an affective disorder. Similarly, of those who met criteria for cannabis dependence and who also met criteria for an anxiety disorder, 80% sought help, compared to 16% of those without an anxiety disorder. This means that people coming to the attention of treatment services will be much more likely to have multiple problems; these need to be addressed in treatment.

1 INTRODUCTION

Cannabis is the most widely used illicit substance in the Australian population, as it is in other countries (Australian Institute of Health and Welfare, 1999; Hall, Johnston, & Donnelly, 1999; Makkai & McAllister, 1998; Smart & Ogborne, 2000). Because so many people in these countries report using cannabis, it is of interest to examine whether cannabis use is in any way associated with mental health and well-being, and if so, how?

1.1 HOW DO WE MEASURE PSYCHIATRIC ILLNESS AND SUBSTANCE USE PROBLEMS?

The way in which a construct (for example, depression) is operationalised is an important issue to consider (Angold, Costello, & Erkanli, 1999; Caron & Rutter, 1991). The measurement of psychiatric illness and substance use problems has undergone considerable change over the past century. For example, in the past three decades the concept of a substance "dependence syndrome" has emerged, influenced by the work of Edwards and colleagues on alcohol dependence (Edwards & Gross, 1976). There has been a move away from less defined concepts of mental health and psychopathology, to classification systems of increasing specificity; and an increasing awareness of the implications for diagnosis that follow from using hierarchical diagnostic systems such as those developed by Kraeplin (Boyd, Burke, Gruenberg, & al., 1984; Klerman, 1990). The predominant classification of mental health in psychiatry has been redefined through successive versions of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders - DSM-I, DSM-II, DSM-III, DSM-III-R, and DSM-IV (American Psychiatric Association, 1952; 1968; 1980; 1987; 1994).

Is the measurement of behaviour best achieved through categorical, and disorder-based coding, or with dimensional scales? This issue has been the subject of much discussion in the mental health literature (e.g. (Eisenberg, 1986; Fergusson & Horwood, 1995).

It may be the case that categorically-based definitions of psychopathology mark a distinction between two distinct populations. This has been found for some childhood disorders (Fergusson, Horwood, & Lynskey, 1994). Categorical representations of psychopathology are also better suited to some types of analyses, for example, non-linear regression. Further, categorical representations can be of use at a service provision level, serving to delineate "cases" and "non-cases" (Kendell, 1975).

However, continuously structured measures of behaviour may provide more precise measurement of behaviour, and they give greater statistical power to detect differences between groups (Cohen, 1983). There may also be clinical benefits associated with dimensional representations of psychopathology. For instance, dimensional classifications of psychosis have been shown to be better predictors of need for treatment (van Os et al., 1999), treatment response (Johnstone, Crow, Frith, & Owens, 1988), and prognosis (Van Os et al., 1996). Further, it may be the case that comorbidity is a marker of the symptom severity of two disorders (Angold et al., 1999), which would not be reflected by categorical measures of psychopathology.

Research has largely relied upon categorical representations of substance use, on a use/no use, or use disorder/no use disorder basis, with little investigation of different ways of operationalising involvement with substance use and psychopathology. Similarly, much remains unknown about how different measures of psychopathology (dimensional and categorical) are related to substance use.

1.2 WHAT IS COMORBIDITY?

Comorbidity has been discussed as an issue of importance for quite a number of years (Feinstein, 1970). Discussion of its importance in psychiatry and psychology has emerged largely within the past few decades (Wittchen, 1996). This has accompanied the changes in the measurement of psychiatric illness discussed above (Boyd et al., 1984; Klerman, 1990).

"Comorbidity" was defined by Feinstein as "any distinct clinical entity that has co-existed or that may occur during the clinical course of a patient who has the index disease under study" (p.456-7) (Feinstein, 1970). In a narrow sense, "morbidity" refers to disorders or diseases, as opposed to associations between symptoms, and comorbidity has commonly been used to refer to the overlap of two or more psychiatric disorders (Boyd et al., 1984). Considerable research has been conducted into this issue in recent years, accompanied by claims that an examination of comorbidity is the "premier challenge facing mental health professionals in the 1990s" (Kendall & Clarkin, 1992).

More recent work has begun to consider comorbidity in a less simplified manner. First, it is possible to make a distinction between two types of comorbidity. One is *homotypic comorbidity*: this refers to the co-occurrence of disorders within a diagnostic grouping (Angold et al., 1999). The co-occurrence of two different substance use disorders may be thought of as homotypic comorbidity. The other is *heterotypic comorbidity*. This refers to the co-occurrence of two disorders from different diagnostic groupings (Angold et al., 1999). This might include the co-occurrence of a substance use disorder and an anxiety disorder.

A further issue to keep in mind when examining comorbidity concerns the temporal association between two disorders. As will be discussed below, several epidemiological studies have examined *lifetime* comorbidity, which means that a person may have met criteria for two disorders at two very different points in their life; this has been termed *successive comorbidity* by Angold and colleagues (1999). Comorbidity between two disorders within the same year may perhaps have greater implications for public health and service provision, because the two disorders are much more likely to have occurred together or within a short time of each other. This has been discussed by Angold et al. (1999) as *concurrent comorbidity*.

1.2.1 MEASUREMENT OF COVARIANCE

Research into comorbidity has largely focussed on the co-occurrence of categorical disorders, however, as outlined above, the way in which a construct is operationalised is an important issue (Angold et al., 1999; Caron & Rutter, 1991). Research on comorbidity has largely relied upon categorical representations of substance use, on a use/no use, or use disorder/no use disorder basis, with little investigation of different ways of operationalising involvement with substance use and psychopathology. Similarly, much remains unknown about how different measures of psychopathology (dimensional and categorical) are related to substance use. In this paper, we will use both continuous and dichotomous measures to explore the covariance between cannabis use and mental health. A review of the limited research evidence in this field is provided below.

1.3 CANNABIS USE AND COMORBIDITY

1.3.1 CANNABIS USE AND OTHER DRUG USE

The co-occurrence of cannabis use with other substance use (homotypic comorbidity) has been a consistent finding in the clinical literature. Inpatients with substance use disorders are more likely than those with other mental disorders to use tobacco (Hays, Farabee, & Miller, 1998). Those using cannabis more often have been found to be more likely to currently smoke, and to smoke daily (Henningfield, Clayton, & Pollin, 1990), and outpatients with more symptoms of problematic use of drugs (Hays et al., 1998; Henningfield et al., 1990), are more likely to smoke tobacco.

However, it is important to obtain representative samples of the general population to ensure that patterns of comorbidity are not affected by selection biases (Berkson, 1946; Galbaud Du Fort, Newman, & Bland, 1993). The US Epidemiological Catchment Area (ECA) study assessed the prevalence of DSM-III mental disorders in representative samples from 5 sites across the US (Robins & Regier, 1991). Approximately one in 23 persons (4.4%) had met criteria for DSM-III cannabis abuse or dependence in their lifetime, 38% of who experienced problems in the past year (Anthony & Helzer, 1991). Among cannabis *users*, 36% met lifetime criteria for an alcohol use disorder (Helzer, Burnam, & McEvoy, 1991). More detailed information on cannabis was not specifically reported, with cannabis combined with other illicit drugs to define "drug use" disorders (of which cannabis use disorders were the most common). The rate of lifetime alcohol use disorders among persons with *any* drug use disorder was 4.1 times greater than among those without a drug use disorder (Anthony & Helzer, 1991). Similarly, the representative US National Comorbidity Survey (NCS) found that DSM-III-R drug use disorders were likely to co-occur with alcohol use disorders (Kessler et al., 1997).

The Ontario Health Survey, a representative household survey of adults aged 15 to 64 years in Ontario, found that 18% of those who met lifetime criteria for DSM-III-R alcohol abuse or dependence met lifetime criteria for DSM-III-R cannabis abuse or dependence, compared to 1.3% of those who had never met criteria for an alcohol use disorder (Ross, 1995).

Longitudinal research has found that adolescents who use cannabis are more likely to later use alcohol, tobacco and other illicit drugs (Fergusson & Horwood, 1997; Fergusson & Horwood, 2000; Kandel, 1984). For example, among adolescents who had used cannabis more than 10 times by age 15-16 years, over half (58%) met criteria for alcohol abuse/dependence by age 16-18 years and two thirds (63%) had used other substances; in comparison, one third (33%) of those who had used cannabis 1-9 times by the age of 15-16 years, and 15% of those who had not used cannabis, met criteria for a an alcohol use disorder by age 16-18 years; and 21% and 4%, respectively, had used other drug types (Fergusson & Horwood, 1997).

1.3.2 CANNABIS USE AND DEPRESSION

There has been recent public concern over putative links between cannabis use and depression, with some claims that cannabis use may cause depression. This may have been of greater concern given the fact that in recent decades, there has been a marked increase in the prevalence of cannabis use among young people in Australia (Australian Institute of Health and Welfare, 1999; Donnelly & Hall, 1994; Makkai & McAllister, 1998), and a dramatic increase in the suicide rate among young Australian males (Cantor, Neulinger, & De Leo, 1999; Lynskey, Degenhardt, & Hall, 2000).

Unfortunately, despite these concern, there has been relatively little research examining the comorbidity between cannabis use and depression. Typically, research in this area has combined cannabis use disorders with other substance use disorders. For example, the ECA found that those meeting lifetime criteria for DSM-III drug use disorders had rates of lifetime DSM-III affective disorders that were between 3.5 and 10.7 times higher than among those without drug use disorders (Anthony & Helzer, 1991). An analysis of the NCS data found that among those meeting criteria for lifetime major depression, 13% met criteria for lifetime drug dependence and 6.5% for abuse, rates that were 2.0 and 1.8 times higher, respectively, than among those not meeting criteria for lifetime depression (Kessler et al., 1996).

In the ECA, those meeting 12-month criteria for DSM-III-R major depression, 7.5% met criteria for drug dependence and 1.1% for drug abuse, rates which were 3.1 and 1.4 times higher, respectively, than among those not meeting 12-month criteria for major depression (Kessler et al., 1996). Again, these figures were not broken down for cannabis abuse and dependence.

One diagnostic issue regarding estimated rates of 12-month disorders in the ECA and NCS was that those regarded as meeting 12-month criteria for cannabis dependence were those who met lifetime criteria (any three symptoms at any point in their lifetime) and one symptom of dependence in the past year. In contrast, the US National Longitudinal Alcohol Epidemiologic Survey (NLAES), a nationally representative survey of US adults, used criteria that required three dependence criteria to be present within the past year (Grant, 1995). It showed that those meeting criteria for DSM-IV major depression within the past 12 months had 6.4 times the odds of meeting criteria for DSM-IV cannabis abuse or dependence than those without major depression (6% vs. 1% respectively)(Grant, 1995).

One study used a sample of cannabis users attending college, with two groups: 45 "heavy users" (used cannabis daily for at least 2 years) and 44 "occasional users" (users who had never used cannabis more than 10 times per month) (Kouri, Pope, Yurgelun-Todd, & Gruber, 1995). These two groups were compared for rates of DSM-III-R psychiatric disorders. The rates of mental disorders were low, with 6% of heavy users and 10% of occasional users meeting criteria for a DSM-III-R mood, anxiety or eating disorder. There were no significant differences between the groups for any psychiatric diagnoses. However, these sample sizes were very small, the sample was young, and it was selected from a college population. Thus, the generalisability of these findings to the general population is limited.

A study of cannabis use and depressive symptoms found that frequency of cannabis use was not associated with depression among a sample of young adult males (Green & Ritter, 2000). A weak association observed between early initiation of cannabis use and depression was not significant after controlling for educational attainment, marital status, and other drug use (alcohol and tobacco use) (Green & Ritter, 2000).

A recent study of male army draftees using cannabis but no other illicit drugs found that more problematic cannabis users had a higher rate of DSM-III-R axis I and axis II psychiatric disorders (Troisi, Pasini, Saracco, & Spalletta, 1998). There was a univariate relationship between increasing involvement with cannabis use (use, abuse and dependence) and increasing scores on the Beck Depression Inventory (BDI) (Troisi et al., 1998). However, the study did not compare these patterns to the rates among draftees who did not use cannabis, or to those who used cannabis *and* other illicit drugs, who would presumably form a large proportion of cannabis users. Further, the DSM-III-R disorders for which the draftees met criteria were not specified.

Some research has examined the association between "general life satisfaction" and cannabis use, as opposed to depression in particular. Research with a cohort of young adults found that greater involvement with cannabis was associated with a lower degree of life satisfaction, and a higher chance of having consulted a mental health professional or having been hospitalised for a psychiatric disorder (Kandel, 1984). Some research has found that cannabis use may be related to general social functioning (Shedler & Block, 1990). Among a cohort of adolescents followed longitudinally, those who had experimented with cannabis reported better social adjustment than those who had never used cannabis, and those who were heavy users. This U shaped curve was thought to indicate that cannabis use needed to be considered within social and personal contexts, and that patterns of use were symptomatic of underlying psychological states, rather than being causes of them. Problematic cannabis use was argued to be a symptom of emotional distress and maladjustment, while experimentation was an indicator of being well adjusted. Never having tried cannabis use was argued to be symptomatic of poor social adjustment, anxiety, and emotional constriction (Shedler & Block, 1990). However, these relationships could have been affected by the prevalence of cannabis use in this birth cohort, who went through adolescence when rates of cannabis use were very high.

More recently, a study examining similar groups of adolescents according to cannabis use (abstainers, experimenters and frequent users) found differences between abstainers, and experimenters, and frequent users of cannabis, who had higher levels of depression according to the Brief Symptom Inventory (BSI) (Milich et al., 2000). "Heavy" users were defined as those using cannabis at least 40 times *and at least one other illicit drug*, while experimenters had used cannabis less than 10 times and had not used more than one other illicit drug; while abstainers had not used cannabis or any other illicit other drugs. Hence the drug use patterns of these groups differ in more ways than simply their frequency of cannabis use.

1.3.3 CANNABIS USE AND ANXIETY

There has been some discussion in the research literature over whether cannabis use is related to acute levels of anxiety. Unfortunately, there has been a paucity of research conducted to examine how more lasting anxiety *levels*, or anxiety *disorders,* and cannabis use are related. What follows is a discussion of the research available on the subject.

Research involving animals has found that while acute administration of cannabis did not change anxiety-related behaviours compared to controls, chronic cannabis administration significantly reduced anxiety-related behaviours in research paradigms involving animals (Sethi et al., 1986). Other research involving animals has suggested that this anxiolytics effect (i.e. anxiety-reducing effect) could be due to one of the major compounds in cannabis, cannabidiol (CBD)(Guimaraes, Chiaretti, Graeff, & Zuardi, 1990). This research found that CBD reduced anxiety behaviours in animals placed in a test situation (Guimaraes et al., 1990). This effect was similar to that observed when diazepam (a benzodiazepine that has anxiolytics effects) was used with the animals (Guimaraes et al., 1990). Other research has found that another of the major components of cannabis, Δ^9tetrahydrocannabinol (Δ^9THC), may have an anxiogenic effect, i.e. that it *increases* levels of anxiety (Zuardi, Shirakawa, Finkelfarb, & Karniol, 1982). However, cannabidiol was found to reduce this effect. Since administration of the whole cannabis extract was found to *decrease* levels of anxiety (Sethi et al., 1986), it may be that CBD counteracts the anxiogenic effects of THC.

Research involving self-reported experiences of cannabis use has provided mixed results, which appear to depend according to the group sampled. A study of 14 volunteers was conducted in the early 1970s to examine the effects of cannabis on anxiety levels (Abel, 1971). All subjects knew

beforehand whether they would be smoking cannabis or not (8 received cannabis, and 6 served as controls), and controls were not given any comparable treatment to the cannabis cigarettes. Those who used cannabis reported significantly greater changes in anxiety levels – which were reductions in anxiety - than controls (Abel, 1971).

A study of 5 long-term cannabis users (use for at least 5 years) was conducted in which their physiological responses to cannabis use were measured (Gale & Guenther, 1971). The study found that physiological responses of subjects were consistent with lower levels of anxiety, compared to when no cannabis had been used (Gale & Guenther, 1971).

One study of 50 long term cannabis users - who had used cannabis on at least 5,000 separate occasions - found that at least half of users reported cannabis occasionally or frequently relieved unpleasant mood states such as anxiety or depression, while the remainder felt it was unrelated to such feelings (Gruber, Pope, & Oliva, 1997). Conversely, one third of the same users reported that cannabis occasionally led to feelings of anxiety, with 10% reporting the same for feelings of depression (Gruber et al., 1997). Given that these persons had used cannabis on so many occasions, it is perhaps unsurprising that few reported unpleasant symptoms associated with their cannabis use.

Nevertheless, one of the most common adverse reactions to cannabis use, predominantly among naïve users, is an anxiety or panic reaction (Hall, Solowij, & Lemon, 1994; Thomas, 1993; Weil, 1970). Furthermore, research with patients in treatment for DSM-III panic disorder, compared with those in treatment for depression and control subjects, found that those with panic disorder reported more feelings of anxiety after cannabis use than depressed persons or controls (Szuster, Pontius, & Campos, 1988). The authors concluded that although persons with panic anxiety might be just as likely to have ever tried cannabis, they were less likely to continue to do so.

While this research has explored acute anxiogenic effects of cannabis use, a separate issue concerns whether or not cannabis use is associated with anxiety of a more lasting nature. The study of US adolescents discussed above (Milich et al., 2000) found that frequent cannabis users had higher levels of anxiety according to the BSI than those who did not use cannabis, or who had only experimented with it (Milich et al., 2000). However, it must be remembered that "heavy" users were using at least one other illicit drug type, while "experimenters" had not used more than one other drug type, and "abstainers" had used no other drug types.

In the study of male army draftees discussed above, scores on the Spielberger State Anxiety Index (STAI-Y1) were higher among those more heavily involved with cannabis use (dependent or abuse) (Troisi et al., 1998). Cannabis involvement was *not* associated with scores on Spielberger's Trait Anxiety Index (STAI-Y-2) (Troisi et al., 1998).

460 members of a commune who had used cannabis were interviewed in a study of cannabis use and psychological distress (Zablocki, Aidala, Hansell, & White, 1991). Overall, neither the amount or the recency of cannabis use were associated with increased psychological distress as measured by the Symptom Checklist-90's Global Severity Index, the depression index, or the anxiety index (Zablocki et al., 1991). However, in individuals characterised as "highly introspective" - on a scale that included such items as "How much do you think about yourself?" and "How much do you try to figure yourself out?" - the recency of cannabis was associated with higher levels of anxiety and psychological distress (Zablocki et al., 1991).

Finally, rates of lifetime DSM-III anxiety disorders were between 1.9 and 3.3 times more common among those meeting lifetime criteria for DSM-III drug abuse or dependence compared to among those without such a disorder (Anthony & Helzer, 1991).

1.3.4 CANNABIS USE AND PSYCHOSIS

The association between schizophrenia and cannabis use – and the possible reasons for this association - have both been the subjects of considerable attention in the literature (Hall, 1998). Clinical samples of persons with schizophrenia have typically revealed high rates of cannabis *use* (Barbee, Clark, Crapanzo, Heintz, & Kehoe, 1989; Cohen & Klein, 1970; Wheatley, 1998). A survey of schizophrenic outpatients in an Australian regional service found that 17% had used cannabis in the past 6 months, with 4% meeting DSM-III-R criteria for cannabis abuse and a further 9% for dependence (Fowler, Carr, Carter, & Lewin, 1998). In a survey of persons with psychotic illnesses in contact with health services in three Australian cities (Melbourne, Perth and Canberra), conducted as part of the NSMHWB, 25% of persons met lifetime criteria for a cannabis *use disorder* (Jablensky et al., 2000). This is consistent with US and UK research finding high rates of cannabis use disorders among clinical samples of persons with psychotic illnesses (Dixon, Haas, Weiden, Sweeney, & Frances, 1991; Drake & Wallach, 1989; Mueser et al., 2000).

There is less evidence regarding the association between psychosis and cannabis use in general population samples. The ECA found that schizophrenia was 5.9 times more common among persons meeting lifetime criteria for DSM-III drug abuse or dependence (Anthony & Helzer, 1991). There has also been an analysis using ECA data of the relationship between drug use and a "self-reported psychotic experience" (Tien & Anthony, 1990). In this paper, a "case" was a person who reported experiencing at least one psychotic symptom (from 12 Diagnostic Interview Schedule (DIS) items) within a follow up year. Persons under 50 years were included, due to low rates of drug use among older persons, and the increased likelihood that older persons would have organic mental disorders. An age-matched sample of cases (n=477) and controls (n=1,818) were compared in a series of logistic regressions that controlled for baseline mental health problems as well as demographic factors; the drug use variables that were significant were retained in the model. Daily cannabis use (RR = 2.0, 95%CI 1.25, 3.12) was a significant predictor of reporting at least one psychotic symptom during the follow-up year (Tien & Anthony, 1990).

1.3.5 SUMMARY

Despite the limitations in the quality and quantity of research in this area, at present the weight of evidence favours the view that individuals who meet criteria for a cannabis use disorder may have heightened risks of a range of mental health problems including higher levels of depression, anxiety and psychosis. In the next section, we discuss some of the possible explanations for this apparent association.

1.4 EXPLANATIONS OF COMORBIDITY

It is necessary to make a distinction between "artefactual" comorbidity and "true" comorbidity. Artefactual comorbidity refers to comorbidity that arises because of the ways in which samples are selected, or behaviour is conceptualised, measured and classified (Caron & Rutter, 1991). For example, comorbidity may be observed because of biases in the samples used, a factor that is especially relevant when examining patterns of comorbidity among treatment samples (Berkson, 1946; Galbaud Du Fort et al., 1993). Furthermore, artefactual comorbidity would occur if lists of diagnostic criteria of different disorders included the same symptoms (Caron & Rutter, 1991). True comorbidity, on the other hand, refers to the actual co-occurrence of two separate conditions.

There are a number of reasons why two disorders may co-occur (Angold et al., 1999; Caron & Rutter, 1991; Kessler, 1995). First, there may be a causal relationship between them, with the presence of one disorder making another more likely to develop. One hypothesis is that persons develop substance use problems as a result of their attempts to self-medicate symptoms of an existing mental health problem. For example, persons with schizophrenia may use cannabis to alleviate unpleasant psychotic symptoms or the effects of neuroleptic medication.

A second hypothesis is that cannabis use precipitates the mental health problems of some individuals. This has been debated with respect to the association between cannabis and psychosis, with some evidence that the more often that cannabis was used by age 18 years, the higher the risk of receiving a diagnosis of schizophrenia in the next 15 years (Andreasson, Allebeck, & Rydberg, 1987). Comorbidity between drug use problems has also been discussed in causal terms. For instance, there has been speculation that the use of some drugs increases the chances of the later use of other drugs: this "gateway hypothesis" has been proposed for cannabis use leading to the use of other drugs (Kandel & Faust, 1975).

A third possibility is that an indirect causal relationship may exist, in which one disorder does not directly cause a second disorder, but affects a third variable, which increases the risk of the second disorder. For example, research has shown that the presence of early-onset substance use disorders reduces the likelihood of completing high school, of entering college, and of completing college (Kessler, Foster, Saunders, & Stang, 1995). Difficulties encountered because of poor educational achievement may subsequently increase the likelihood of other problems, such as depression or continued drug use problems.

A fourth possibility is that there may not be a causal relationship between two disorders: rather, it may be that common or associated risk factors are shared (Caron & Rutter, 1991; Kessler, 1995). For instance, genetic vulnerabilities have been implicated as increasing the likelihood of cannabis dependence (Kendler & Prescott, 1998a), alcohol dependence (Kendler, Neale, Heath, Kessler, & Eaves, 1994; Kendler, Prescott, Neale, & Pedersen, 1997b), nicotine dependence (Kendler et al., 1999) and cocaine dependence (Kendler & Prescott, 1998b). Common genetic vulnerabilities have been found to predict both nicotine and alcohol dependence in male twins (True et al., 1999). It is possible that vulnerabilities may be similar across other drug types, given that different drugs act upon similar areas and neurotransmitters of the brain.

It is also possible that the co-occurrence of cannabis use problems and other mental health problems reflects the effects of various social, demographic and environmental influences that act to increase the risks of both cannabis use problems and other mental health problems. There is a high degree of similarity between the factors associated with cannabis use, other drug use and mental health problems. These include factors such as social disadvantage, parental psychiatric illness, and family dysfunction (Rutter, 1987; Velez, Johnson, & Cohen, 1989).

Temperament, particularly the trait of neuroticism, may also affect an association. Persons scoring high on measures of neuroticism have been characterised as more anxious, worrying, depressed and moody (Eysenck & Eysenck, 1991). Research with young adults has found that more frequent use of cannabis is associated with higher levels of neuroticism (Sieber & Angst, 1990; Wells & Stacey, 1976). Similarly, persons with cannabis dependence have been found to have significantly higher than normal scores on the neuroticism scale of the EPQ (Bachman & Jones, 1979). Anxiety and depression are also strongly related to higher levels of trait neuroticism (Kendler, Neale, Kessler, Heath, & Eaves, 1992; Martin, 1985).

Finally, links between the use of one substance and an outcome variable may be affected by comorbidity with other substance use. Persons who use one drug type are likely to be using other

drugs (Hays et al., 1998; Helzer et al., 1991; Kessler et al., 1997). Since the relationship between cannabis use and mental health could be due to the effects of other drug use on mental health, this factor needs to be taken into account.

There is little information about general population relationships between cannabis use and mental health in the Australian population. A number of issues about the nature of any relationship between cannabis use and mental health remain largely unexamined. The first concerns the indicators of mental health that are used: what is the relationship between cannabis use and a *range* of different indicators of mental health, including mental disorders, psychological distress and disability? The second concerns the way that cannabis use and mental health are measured: there has been little if any investigation of the association between mental health and cannabis use considered on a more dimensional scale. A third issue concerns whether or not any associations between cannabis use and poor mental health can be explained by other factors: in particular, demographic characteristics, other drug use, and levels of neuroticism.

1.5 AIMS

The current report will examine the above issues using the Australian National Survey of Mental Health and Well-Being (NSMHWB). The NSMHWB provided nationally representative data on the mental and physical health of Australian persons aged 18 years and over. Unlike previous epidemiological surveys, the NSMHWB included measures of role functioning related to physical and emotional health, as well as measures of disability and psychological distress. Hence, the NSMHWB not only provided an opportunity to examine the associations between involvement with substance use and mental disorders, but also to examine the association between substance use and other indicators of psychological well-being. It allows the following questions to be answered:

1. Is there an association between cannabis use, abuse and dependence, and the following:
    a. tobacco, alcohol and other drug use, and DSM-IV alcohol and other drug use disorders;
    b. DSM-IV affective disorders;
    c. DSM-IV anxiety disorders;
    d. screening positively for psychosis;
    e. life satisfaction and psychological distress;
    f. role functioning due to emotional well-being?

2. Are these associations explained by demographic differences between persons who do and do not use cannabis?

3. Are these associations explained by differences in neuroticism between persons who do and do not use cannabis?

4. Are these associations explained levels of other drug use that differ between persons who do and do not use cannabis?

2 METHOD

The NSMHWB sample was representative of residents in private dwellings across all States and Territories in Australia. The survey was conducted by the Australian Bureau of Statistics (ABS) in 1997. The sample excluded special dwellings (hospitals, nursing homes, hostels etc.), and dwellings in remote and sparsely populated areas of Australia. Dwellings were selected using random stratified multistage area sampling, so that each person in all States and Territories had a known chance of participation. One person aged at least 18 years was randomly selected from each dwelling and asked to participate. Approximately 13,600 private dwellings were approached, with a final sample size of 10,641 persons giving a response rate of 78%.

Trained survey interviewers met with each designated respondent to administer the interview. The interviewers were given 24-hour access to a psychiatrist to deal with any concerns that arose in the course of the interview.

Questioning was restricted to symptoms in the last 12 months to minimise the uncertainty about recall of symptoms over longer periods. Mental disorders were assessed by a modified version of the CIDI (World Health Organisation, 1993), which yielded diagnoses of both ICD-10 and DSM-IV disorders. The CIDI is the most widely used interview in large epidemiological studies (Bland, Newman, & Orn, 1988; Robins & Regier, 1991) and CIDI assessments of substance use disorders have been shown to have excellent inter-rater reliability (Cottler et al., 1991; Wittchen et al., 1991) and test-retest reliability (Andrews & Peters, 1998; Cottler et al., 1991; Wittchen et al., 1991). There are fewer studies of the validity of the CIDI assessments for substance use disorders (Andrews & Peters, 1998). In an early study comparing the agreement between the Present State Examination (PSE) and CIDI interviews the agreement for syndromes was adequate (Overall Kappa =0.55) (Farmer, Katz, McGuffin, & Bebbington, 1987). Similarly, Janca et al. (1992) found good levels of agreement between CIDI and clinicians' assessments (Kappa = 0.77). The validity of the CIDI has been further supported by broad agreement between the findings of the ECA and the NCS (Bland et al., 1988; Robins & Regier, 1991). Thus, while community epidemiological surveys may not provide perfect estimates of the prevalence of mental disorders in the community they provide a reasonably reliable and valid portrait of the pattern of disorders in the community.

2.1.1 ASSESSMENT OF ALCOHOL, CANNABIS AND OTHER DRUG USE

Respondents were asked if they had consumed at least 12 standard drinks (10g alcohol) within the past 12 months. All those who reported such use, and who had consumed more than 3 standard drinks on one occasion, were assessed for symptoms of alcohol use disorders.

All persons were asked whether they currently used tobacco; if so, they were asked if their use was regular (at least daily).

Persons were asked if they had used cannabis, stimulants, sedative or opiates more than five times in the past 12 months; if so, they were assessed for symptoms of a use disorder. Respondents were asked separate questions about their use of cannabis, stimulants, sedatives and opioids. The questions asked about the use of drugs such as cannabis and the "extramedical use" of prescribed drugs such as benzodiazepines. The questions asked whether drugs and medicines had been used "in larger amounts than was prescribed or for a longer period than was prescribed" or used "more than five times when they were not prescribed for you, to get high, to relax, or to make you feel

better, more active, or alert". Additional questions covered age of onset of use, frequency and recency of use of each of four drug groups. The drug groups were selected to reflect the most widely used extramedical drugs among Australian adults, as indicated in the Australian National Drug Strategy Household surveys (Australian Institute of Health and Welfare, 1999) and included:

- cannabis (marijuana & hashish);
- amphetamines, ecstasy, speed and other stimulants which can be obtained by medical prescription including, dexedrine, preludin and ritalin;
- barbiturates and tranquillisers and other sedatives which can be obtained by medical prescription including, ativan, librium, megaton, normison, rohypnol, serepax, valium, xanax;
- opioids such as heroin and opium as well as other opioids and analgesics which can be obtained on medical prescription including, codeine, doloxene, methadone, morphine, percodan and pethidine.

Respondents were given a detailed verbal description of each drug group and lists of drugs in each class. The interviewer read the questions and recorded the participants' responses on a laptop computer. This use of a computer to record answers in real-time differed from the ECA and NCS, which used pencil and paper. Studies have since shown excellent agreement between responses recorded via pencil and paper and those recorded via laptop computer (Peters, Clarke, & Carroll, 1999).

2.1.2 DIAGNOSTIC ASSESSMENT OF MENTAL DISORDERS

The following DSM-IV disorders were assessed in the interview:

1. Substance use disorders: cannabis abuse and dependence, as well as abuse and dependence on: alcohol, opiates, stimulants, and sedatives;
2. Affective disorders: major depressive disorder, dysthymia, bipolar I disorder, bipolar II disorder; and
3. Anxiety disorders: panic disorder, agoraphobia, social phobia, generalised anxiety disorder, obsessive-compulsive disorder, and post-traumatic stress disorder.

2.1.2.1 Diagnostic assessment of cannabis use disorders

DSM-IV Abuse criteria require a pattern of substance use that is causing clinically significant distress or impairment. This distress or impairment may involve a failure to fulfil role obligations, use in hazardous situations, or legal, social or interpersonal problems.

DSM-IV Dependence criteria require a cluster of three or more indicators that a person continues use despite significant substance related problems. These include: tolerance to the effects of alcohol or other drugs; a withdrawal syndrome on ceasing or reducing use; substance used in larger amounts or for a longer period than intended; a persistent desire or unsuccessful efforts to reduce or cease use; a disproportionate amount of time spent obtaining, using and recovering from use; social, recreational or occupational activities are reduced or given up due to substance use; and use continues despite knowledge of physical or psychological problems induced by substance use.

2.1.3 OTHER MEASURES OF MENTAL HEALTH AND WELL-BEING

A short scale was also included that screened for the likelihood of psychosis (the Psychosis Screener (PS)). Analyses suggest that this screener is moderately effective for screening persons who satisfy criteria for schizophrenia or schizoaffective disorder[1].

Several other measures of psychological well-being were included in the survey, and were used in the present analyses:

1. Kessler's Psychological Distress scale, which assesses symptoms of nervousness, restlessness and depressed affect (Kessler, 1996).
2. The General Health Questionnaire (GHQ), which was designed as a screening instrument to detect likely non-psychotic psychiatric "cases" in general health care settings (Goldberg & Williams, 1988). In the present analyses, both the categorical (screening positive as a likely case) and continuous methods of scoring the GHQ will be used.
3. The Short Form 12 (SF-12) was also included, which assesses possible limitations in both physical and mental health: the mental component summary (MCS) examines role limitations due to emotional and mental health problems (Ware, Kosinski, & Keller, 1996).
4. As an indicator of general life satisfaction, participants were asked the following question: "How do you feel about your life as a whole, taking into account what has happened in the last year and what you expect to happen in the future?" Participants rated their view on a scale from 1 ("Delighted") to 7 ("Terrible") – referred to as the "Delighted-Terrible" scale.

2.2 DATA ANALYSIS

Involvement with cannabis use was categorised as a four level variable: fewer than 6 occasions of use in the past 12 months (termed "no use"), use without meeting criteria for DSM-IV abuse or dependence ("cannabis use"), DSM-IV cannabis abuse, and DSM-IV cannabis dependence.

Weighted estimates of the 12-month prevalence of DSM-IV cannabis use disorders are presented in this report. Estimates were weighted to conform to independent population estimates by State, part of State, age and sex. In addition, balanced repeated replicate weights were used to account for the complex survey sampling design. All prevalence estimates and their standard errors were calculated using SUDAAN Version 7.5.3 (Research Triangle Institute, 1997).

[1] Unpublished analyses; details can be obtained from the authors of this report.

2.2.1 MULTIVARIATE ANALYSES

Multivariate logistic regressions were carried out for each dichotomous outcome variable (e.g. presence/absence of a DSM-IV affective disorder). All analyses were carried out using STATA 5.0 for Windows (STATA Corporation, 1997). In these analyses, the following steps were carried out:

1. A univariate logistic regression in which only the cannabis involvement variable was included. Cannabis involvement was dummy coded, with each level of involvement (cannabis use without disorder, DSM-IV cannabis abuse, DSM-IV cannabis dependence) compared to non-users as the reference category.

This was followed by a series of multivariate logistic regression analyses in which the following sets of variables were added in the regression model at each subsequent step:

2. Demographic variables:
    a. Gender (reference category: female);
    b. Age (reference category: 18-24 years, compared to 25-34, 35+);
    c. Education (reference category: completed less than secondary education, compared to completed secondary education, completed post-secondary education);
    d. Marital status (reference category: currently married/de facto; compared to separated/divorced/widowed/never married);
    e. Employment status (reference category: employed full-time/part-time; compared to unemployed, not in the labour force).

3. Other drug use. This was coded in the following manner:
    a. Regular (daily) tobacco use (reference category no regular use);
    b. DSM-IV alcohol use disorder in the past 12 months (reference category: no use disorder);
    c. Other drug use (stimulant, sedative or opiate use) in the past 12 months (reference category: no use). Note that when a drug use variable was the outcome variable (e.g. presence or absence of a DSM-IV alcohol use disorder), the related drug use predictor was not included in the analysis (e.g. other drug use was not included in the analysis when a DSM-IV other drug use disorder was the outcome variable).

4. EPQ Neuroticism score.

For linear outcome variables (e.g. score on the GHQ) the same analysis procedure was used, with linear regression rather than logistic regression.

3 RESULTS

3.1 PREVALENCE AND CORRELATES OF CANNABIS USE

Around 1 in 20 persons (4.8%) reported using cannabis in the past year without meeting criteria for a DSM-IV use disorder. A further 0.8% met criteria for cannabis abuse, while 1.5% met criteria for cannabis dependence (Table 1). Applying these estimates to the known Australian population over 18 years of age (approximately 13,465,000), around 300,000 adults in Australia met criteria for a DSM-IV cannabis use disorder within the past year, with another 650,000 using cannabis without meeting criteria for a cannabis use disorder.

Males were more likely than females to have used cannabis in the past year (6.5% vs. 3.3%), to have met criteria for cannabis abuse (1.3% vs. 0.2%), and to have met criteria for cannabis dependence (2.3% vs. 0.7%).

Table 1: Demographic characteristics of persons by involvement with cannabis use

	No Cannabis use % (SE)	Cannabis use % (SE)	Cannabis abuse % (SE)	Cannabis dependence % (SE)
Prevalence	92.8	4.8	0.8	1.5
Weighted N	(12,511,000)	(652,000)	(102,000)	(200,000)
Female	95.8 (0.6)	3.3 (0.4)	0.2 (0.07)	0.7 (0.2)
Male	89.9 (0.5)	6.5 (0.4)	1.3 (0.2)	2.3 (0.4)
Age group				
18-24	80.2 (1.9)	11.8 (1.5)	2.1 (0.6)	5.9 (0.8)
25-34	87.6 (1.0)	8.4 (0.7)	1.6 (0.4)	2.4 (0.4)
35 +	97.2 (0.3)	2.3 (0.4)	0.2 (0.06)	0.3 (0.06)
Education				
Less than secondary	93.3 (0.5)	4.0 (0.4)	0.8 (0.2)	1.9 (0.3)
Secondary only	91.2 (1.0)	6.3 (1.0)	0.7 (0.2)	1.8 (0.6)
Post-secondary	93.2 (0.6)	4.9 (0.5)	0.8 (0.2)	1.1 (0.2)
Not currently married/de facto	87.4 (1.4)	8.2 (0.9)	1.4 (0.3)	3.0 (0.5)
Married/de facto	95.9 (0.3)	3.1 (0.3)	0.4 (0.1)	0.7 (0.2)
Employed	91.8 (0.7)	5.8 (0.4)	0.9 (0.2)	1.5 (0.3)
Unemployed	74.5 (2.7)	13.0 (2.3)	3.8 (1.2)	8.8 (2.6)
Not in the labour force	97.4 (0.4)	2.0 (0.4)	0.13 (0.07)	0.5 (0.2)
Mean EPQ score	2.5 (0.03)	3.1 (0.13)	3.6 (0.33)	4.1 (0.25)

Cannabis use was much more likely among younger persons (Table 1). Around one in 8 persons aged 18-24 years (12%) reported cannabis use without meeting criteria for a use disorder, compared to 2% of those 35 years and over. Similarly, the prevalence of dependence decreased from 6% among those aged 18-24 years, to 0.3% among those aged 35 years and over.

Those who were least educated were most likely to have met criteria for cannabis dependence within the past year, while non-dependent use was most likely among those with secondary education. Employment status was also related to cannabis involvement, with those who were currently unemployed most likely to report cannabis use (13%), abuse (4%) and dependence (9%). In contrast, very few of those who were not currently in the labour force reported using cannabis (2%), or met criteria for cannabis abuse (0.1%) or dependence (0.5%).

Compared to non-users of cannabis (M = 2.5), mean scores on the Neuroticism scale of the EPQ were higher among those who used cannabis (M = 3.1), met criteria for cannabis abuse (M = 3.6), and highest among those meeting criteria for dependence (M = 4.1).

3.2 CANNABIS USE AND OTHER DRUG USE

The prevalence of other substance use, and DSM-IV substance use disorders according to level of cannabis use, is shown in Table 2. Among those with heavier involvement with cannabis, regular tobacco use became much more likely. Around one fifth (20%) of those who reported no cannabis use in the past year reported being regular smokers. This proportion increased dramatically among those who did report cannabis use. Half of those who reported cannabis use (without meeting criteria for a use disorder) were regular smokers (51%), and 70% of those meeting criteria for cannabis dependence were regular smokers (Table 2).

Table 2: Prevalence (%) of substance use and DSM-IV substance use disorders by involvement with cannabis use

	No cannabis use % (SE)	Cannabis use % (SE)	Cannabis abuse % (SE)	Cannabis dependence % (SE)
% Regular tobacco use	20.7 (0.5)	51.1 (2.6)	60.1 (7.2)	70.4 (8.6)
% Alcohol use	72.1 (0.6)	94.3 (1.8)	94.9 (2.9)	87.4 (2.9)
% Daily alcohol use	19.2 (0.4)	27.2 (2.1)	26.2 (8.8)	15.3 (3.8)
% Alcohol use disorder	4.5 (0.4)	20.4 (2.1)	37.1 (7.6)	37.1 (6.1)
% Sedative, stimulant or opiate use	2.6 (0.2)	14.4 (2.2)	12.4 (4.1)	26.8 (9.0)
% Sedative, stimulant, opiate use disorder	0.5 (0.1)	3.1 (1.1)	4.1 (3.2)	17.6 (6.7)

Table 3 shows the unadjusted odds ratios of other substance use, as well as the adjusted odds ratios produced after controlling for demographics, other drug use and neuroticism; Appendix A also shows the odds ratios produced after controlling for demographics; and after controlling for demographics and other drug use. Table 3 shows that cannabis users were between 4.3 times (cannabis users) and 8.9 times (those meeting criteria for cannabis dependence) more likely to be regular smokers than those who reported no cannabis use in the past year (Table 3, unadjusted ORs). Even after other drug use, demographic characteristics, and EPQ scores were taken into account, cannabis users remained around 3 to 4 times more likely than non-users to smoke regularly (adjusted ORs, Table 3; Appendix A).

Table 3: Univariate and adjusted odds ratios (OR) and 95% confidence intervals (95%CI) for drug use according to cannabis use

	OR[1]	95%CI	Adjusted OR[1]	Adjusted 95%CI
Regular tobacco use				
Cannabis use	4.34	3.61, 5.22	3.06	2.51, 3.71
Cannabis abuse	5.62	3.55, 8.92	2.75	1.69, 4.47
Cannabis dependence	8.94	6.25, 12.77	4.31	2.94, 6.30
Alcohol use				
Cannabis use	5.99	4.16, 8.65	3.78	2.60, 5.53
Cannabis abuse	5.77	2.33, 14.30	3.05	1.20, 7.74
Cannabis dependence	2.46	1.55, 3.90	1.42	0.87, 2.33
Alcohol use daily				
Cannabis use	1.60	1.31, 1.97	2.01	1.59, 2.54
Cannabis abuse	1.46	0.87, 2.43	1.97	1.13, 3.43
Cannabis dependence	0.82	0.53, 1.28	1.27	0.78, 2.06
Alcohol use disorder				
Cannabis use	5.55	4.37, 7.04	2.20	1.68, 2.89
Cannabis abuse	13.07	8.17, 20.91	3.67	2.19, 6.17
Cannabis dependence	11.82	8.33, 16.74	2.57	1.71, 3.86
Other drug use				
Cannabis use	5.81	4.37, 7.69	4.57	3.32, 6.30
Cannabis abuse	5.35	2.72, 10.49	3.35	1.60, 6.96
Cannabis dependence	11.32	7.61, 16.79	6.94	4.39, 11.02
Other drug use disorder				
Cannabis use	5.58	3.14, 9.98	3.13	1.65, 5.92
Cannabis abuse	7.27	2.22, 23.76	3.03	0.84, 10.98
Cannabis dependence	34.52	20.49, 56.83	14.54	7.66, 27.61

1. All odds ratios use "no cannabis use" group as the reference category

Similar relationships existed between cannabis involvement and alcohol use. Cannabis users (regardless of level of involvement) were all more likely than non-users to report alcohol use in the past year, and to meet criteria for a DSM-IV alcohol use disorder (Table 2, 3). Furthermore, those who met criteria for a DSM-IV cannabis use disorder were more likely to also meet criteria for a DSM-IV alcohol use disorder (37%) than those who had used cannabis without meeting criteria for a use disorder (20%). This can be seen in the unadjusted odds ratios shown in Table 3: compared to non-users, cannabis users were 5.6 times more likely to meet criteria for an alcohol use disorder (95%CI 4.4, 7.0), while those who met criteria for cannabis abuse were 13.1 times more likely (95%CI 8.2, 20.9) and those who met criteria for cannabis dependence were 11.8 times more likely (95%CI 8.3, 16.7).

These relationships between cannabis use and alcohol use remained significant after controlling for other factors that may have accounted for the association: demographic characteristics, other drug use, and neuroticism (Table 3, adjusted ORs; Appendix A). Cannabis users and those who meet criteria for cannabis abuse were still more likely than non-users to report alcohol use, and to report daily alcohol use. However, those who met criteria for cannabis dependence were no more likely to have either used alcohol or to report daily alcohol use, compared to non-users of cannabis, after adjustment for other factors. Nevertheless, *all* cannabis users (including those who were cannabis dependent) were more likely than non-users to meet criteria for an alcohol use disorder (Table 3, adjusted OR between 2.2 – 3.7).

The same pattern was found for the use of sedatives, stimulants or opiates ("other drug use"). Cannabis users were all much more likely to report using at least one of these other drug types (cannabis use 14%, cannabis abuse 12%, cannabis dependence 27%) compared to non-users (3%; Table 2, 3). These relationships all remained significant after controlling for other factors, with odds ratios among cannabis users remaining between 3.4 – 6.9 times greater relative to non-users (Table 3, adjusted ORs; see also Appendix A).

Similarly, cannabis users were all much more likely to meet criteria for other drug use disorders (Table 2, 3). Approximately 0.5% of non-users met criteria for an other drug use disorder, compared to 3% of cannabis users, 4% of those meeting criteria for cannabis abuse, and 18% of those meeting criteria for dependence (caution must be taken when interpreting these figures, given the large error bands around the estimates). These relationships largely remained significant after controlling for other factors as mentioned above (Table 3; see also Appendix A), with those meeting criteria for cannabis dependence the most likely to meet criteria for an other drug use disorder compared to non-users of cannabis after taking into account other factors (OR 14.5, 95%CI: 7.7, 27.6).

3.3 CANNABIS USE AND DEPRESSION AND ANXIETY

Strong univariate relationships existed between involvement with cannabis and the prevalence of affective and anxiety disorders (Table 4, 5). The prevalence of affective disorders increased from around 6% of non-users to 14% of those meeting criteria for cannabis dependence. Cannabis users had around 2-3 times greater likelihood of meeting criteria for an affective disorder compared to non-users (Table 5, unadjusted odds ratios).

Table 4: Prevalence (%) of DSM-IV affective and anxiety disorders by cannabis use

	No cannabis use % (SE)	Cannabis use % (SE)	Cannabis abuse % (SE)	Cannabis dependence % (SE)
% Anxiety disorder	5.4 (0.3)	8.0 (1.2)	6.4 (2.8)	16.5 (3.6)
% Affective disorder	6.2 (0.3)	12.1 (2.7)	18.6 (5.3)	13.6 (2.6)

Similarly, around 5% of non-users met criteria for a DSM-IV anxiety disorder, with this proportion increasing such that almost one in 5 of those meeting criteria for cannabis dependence had an anxiety disorder (17%). Cannabis users (OR 1.8) and those meeting criteria for cannabis dependence (OR 4.3) were more likely than non-users to meet criteria for an anxiety disorder (Table 5, unadjusted odds ratios).

Using the NSMHWB data, it was possible to calculate that among those who met criteria for cannabis dependence, two thirds (64%) with an affective disorder sought help, compared to one fifth (21%) of those without an affective disorder. Similarly, of those who met criteria for cannabis dependence and who also met criteria for an anxiety disorder, 80% sought help, compared to 16% of cannabis dependent persons without an anxiety disorder.

Table 5: Univariate and adjusted odds ratios (OR) and 95% confidence intervals (95%CI) of DSM-IV affective and anxiety disorders according to cannabis use

	OR[1]	95%CI	Adjusted OR[1]	Adjusted 95%CI
DSM-IV affective disorder				
Cannabis use	2.24	1.73, 2.91	1.30	0.94, 1.79
Cannabis abuse	2.88	1.61, 5.17	1.50	0.75, 2.99
Cannabis dependence	2.85	1.86, 4.35	0.91	0.54, 1.53
DSM-IV anxiety disorder				
Cannabis use	1.78	1.31, 2.41	0.88	0.60, 1.29
Cannabis abuse	1.10	0.44, 2.73	0.37	0.13, 1.05
Cannabis dependence	4.30	2.88, 6.40	1.40	0.84, 2.37

1. All odds ratios use "no cannabis use" group as the reference category

However, these relationships did not remain significant after controlling for demographics, other drug use and neuroticism (Table 5, adjusted odds ratios; Appendix A). In particular, once other drug use was controlled (regular tobacco use, alcohol use disorders and other drug use), rates of anxiety and affective disorders were no longer significantly different form non-users (Table 5, Appendix A).

3.4 CANNABIS USE AND PSYCHOLOGICAL DISTRESS AND DISABILITY

Table 6 shows mean scores on a number of indicators of psychological distress and well-being according to the level of cannabis use. The GHQ was designed as a screening instrument to detect likely non-psychotic psychiatric "cases" in general health care settings (Goldberg & Williams, 1988). Kessler's Psychological Distress scale assesses symptoms of nervousness, restlessness and depressed affect (Kessler, 1996). The mental component summary of the Short Form 12 (SF-12) assesses role limitations due to emotional and mental health problems (Ware et al., 1996). Finally, the "Delighted-Terrible" question assessed how respondents felt about their life as whole, given what had happened in the past year and what they expected to happen in the future.

On a univariate level, mean scores on the GHQ increased as involvement with cannabis increased (from M = 0.9 among non-users, to 1.7 among those who met criteria for cannabis dependence), indicating that those who were more heavily involved with cannabis use reported significantly more symptoms of psychological distress (Table 6, 7). Scores on Kessler's Psychological Distress scale showed a similar pattern (lower scores indicate greater psychological distress). Compared to non-users, all cannabis users reported significantly higher levels of psychological distress according to this scale (Table 6, 7).

Table 6: Mean scores on measures of physical and mental well-being by involvement with cannabis use

	No cannabis use M (SE)	Cannabis use M (SE)	Cannabis abuse M (SE)	Cannabis dependence M (SE)
GHQ score	0.9 (0.02)	1.2 (0.10)	1.5 (0.28)	1.7 (0.24)
Kessler's PD scale	45.9 (0.05)	44.9 (0.26)	43.8 (0.58)	42.4 (0.52)
SF-12 mental	52.2 (0.09)	49.9 (0.45)	47.2 (1.23)	45.8 (0.94)
Delighted-Terrible	2.8 (0.01)	2.9 (0.05)	3.1 (0.15)	3.3 (0.11)

At a univariate level, cannabis users also reported significantly higher limitations in role functioning due to emotional problems compared to non-users, as assessed by the SF-12 (Table 6, 7). Compared to non-users, cannabis users also reported less satisfaction with their life in general as measured by the "Delighted-Terrible" scale (Table 6, 7).

Table 7: Results of univariate linear regression of cannabis use on measures of mental health and well-being

	Standardised beta coefficient[1]	Regression coefficient[1]	95%CI	t (sig)
GHQ				
Cannabis use	0.04	0.35	0.18, 0.53	3.88 (<.001)
Cannabis abuse	0.03	0.60	0.16, 1.05	2.66 (<.01)
Cannabis dependence	0.06	1.06	0.74, 1.38	6.49 (<.001)
Delighted-terrible				
Cannabis use	0.02	0.13	0.03, 0.23	2.49 (<.01)
Cannabis abuse	0.03	0.39	0.15, 0.64	3.10 (<.01)
Cannabis dependence	0.07	0.64	0.46, 0.82	7.00 (<.001)
Kessler's PD				
Cannabis use	-0.06	-1.47	-1.94, -1.00	-6.13 (<.001)
Cannabis abuse	-0.04	-2.21	-3.38, -1.05	-3.72 (<.001)
Cannabis dependence	-0.09	-4.19	-5.03, -3.35	-9.79 (<.001)
SF-12				
Cannabis use	-0.06	-2.79	-3.63, -1.95	-6.48 (<.001)
Cannabis abuse	-0.04	-4.58	-6.67, -2.48	-4.28 (<.001)
Cannabis dependence	-0.09	-7.29	-8.80, -5.78	-9.48 (<.001)

1. All coefficients are estimates of the change from "no cannabis use" group as the reference category

The relationship between GHQ scores and cannabis use appeared to be due to the other factors examined here. Differences between cannabis users and non-users remained after controlling for demographic factors (Appendix A), but after controlling for other drug use, only those meeting criteria for cannabis dependence had significantly higher scores than non-users (Appendix A). After also controlling for neuroticism, there were no differences between cannabis users and non-users in scores on the GHQ (Table 8).

For Kessler's psychological distress scale, the difference between non-users and cannabis users/DSM-IV abuse groups appeared to be explained by other factors examined here. In particular, inclusion of other drug use (regular tobacco use, meeting criteria for an alcohol use disorder, and the use of other drugs) in the analysis removed the association with psychological distress (Table 8, Appendix A). Those who met criteria for cannabis dependence still had significantly higher scores on this measure of psychological distress after accounting for all factors examined (Table 8).

Similarly, for the SF-12, the difference between non-users and cannabis users/DSM-IV abuse groups was not significant after adjusting for other drug use (regular tobacco use, alcohol use disorders, and sedative/stimulant/opiate use) (Table 8; Appendix A). Those meeting criteria for cannabis dependence still had significantly higher levels of role limitations according to the SF-12 compared to non-users after accounting for drug use, neuroticism and demographics (Table 8).

There univariate differences in general "life satisfaction" between non-users and cannabis use/DSM-IV abuse groups appeared to be explained by group differences in other drug use, with no significant association remaining after controlling for other drug use (Appendix A). Those meeting criteria for cannabis dependence still had significantly lower levels of general life satisfaction after accounting for all the factors examined here (Table 8).

Table 8: Results of multivariate linear regression of cannabis use on measures of mental health and well-being

	Standardised beta coefficient[1]	Regression coefficient[1]	95%CI	t (sig)
GHQ				
Cannabis use	0.00	0.02	-0.15, 0.19	ns
Cannabis abuse	0.00	0.10	-0.32, 0.51	ns
Cannabis dependence	0.02	0.28	-0.03, 0.58	ns
Delighted-terrible				
Cannabis use	-0.01	-0.05	-0.14, 0.04	ns
Cannabis abuse	0.01	0.07	-0.15, 0.29	ns
Cannabis dependence	0.02	0.17	0.01, 0.34	2.05 (<.05)
Kessler's PD				
Cannabis use	-0.001	-0.002	-0.37, 0.37	ns
Cannabis abuse	0.001	0.06	-0.83, 0.96	ns
Cannabis dependence	-0.02	-0.70	-1.36, -0.04	-2.08 (<.05)
SF-12				
Cannabis use	-0.01	-0.50	-1.24, 0.25	ns
Cannabis abuse	-0.01	-1.21	-3.00, 0.59	ns
Cannabis dependence	-0.03	-2.24	-3.56, -0.92	-3.32 (<.001)

1. All coefficients are estimates of the change from "no cannabis use" group as the reference category

3.5 CANNABIS USE AND PSYCHOSIS

A significant relationship existed between cannabis involvement and the proportion of persons screening positively for psychosis (Table 9, 10). While 0.7% of non-users screened positive, around 2% of users, 4% of those with cannabis abuse, and just fewer than 1 in 15 (7%) of those with cannabis dependence screened positively. These prevalence estimates translated into odds of screening positively for psychosis that were around 4-11 times greater among cannabis users compared to non-users (univariate odds ratios 3.6 – 10.8; Table 10).

Table 9: Prevalence (%) of persons screening positively for psychosis according to cannabis use

	No cannabis use % (SE)	Cannabis use % (SE)	Cannabis abuse % (SE)	Cannabis dependence % (SE)
% Psychosis screen +	0.7 (0.1)	2.4 (0.7)	3.9 (2.8)	6.8 (3.2)

After conducting multivariate analyses that controlled for other drug use, demographic variables, and neuroticism, those meeting criteria for cannabis dependence were still around 3 times more likely to screen positively for psychosis than non-users of cannabis (OR = 2.9, 95%CI: 1.4, 6.0; Table 10). However, cannabis use, and DSM-IV cannabis abuse, were *not* significantly associated with screening positively for psychosis after controlling for the other factors examined here.

Table 10: Odds ratios (OR) and confidence intervals (95%CI) of screening positively for psychosis according to cannabis use

	OR[1]	95%CI	Adjusted OR[1]	Adjusted 95%CI
Psychosis screen +				
Cannabis use	3.56	2.05, 6.23	1.50	0.81, 2.80
Cannabis abuse	4.64	1.43, 14.98	1.78	0.51, 6.23
Cannabis dependence	10.80	5.91, 19.89	2.89	1.39, 5.99

1. All odds ratios use "no cannabis use" group as the reference category

4 DISCUSSION

4.1 SOCIO-DEMOGRAPHIC CORRELATES OF CANNABIS INVOLVEMENT

Cannabis involvement was strongly related to both gender and age. Use, abuse and dependence upon cannabis were all most common among males, and those aged 18 to 24 years. This pattern is consistent with other population research finding that males are more likely to use and abuse cannabis and other drugs (Anthony & Helzer, 1991; Kandel, Chen, Warner, Kessler, & Grant, 1997), and that cannabis use and abuse are both much more common among young adults (Anthony & Helzer, 1991; Anthony, Warner, & Kessler, 1994; Kandel et al., 1997).

The age-related findings may reflect an exposure effect, with evidence suggesting that cannabis use did not become more widely available in Australia until the later part of the 20th century (Manderson, 1993; McCoy, 1980), which would have meant that older persons would have been beyond the period in their lives at which they would have been at greatest likelihood of beginning cannabis use (Chen & Kandel, 1995; Degenhardt, Lynskey, & Hall, 2000). The gender effect may reflect social norms regarding drug use; the use of drugs has typically been more condoned among men. These social norms, however, may be changing, with evidence suggesting that patterns of drug use among more recent cohorts of males and females are becoming more similar (Warner, Kessler, Hughes, Anthony, & Nelson, 1995).

Cannabis involvement was also related to educational achievement, with those who were heavily involved with cannabis use more likely to have completed less education. The same relationship between problematic cannabis use and education has been found with the ECA and the NCS with lifetime cannabis use disorders. While cannabis involvement and education levels were related here, it is not possible using this data to elucidate the nature of any causal mechanisms underlying the association. One possibility is that cannabis use increases the likelihood of completing fewer years of education, a possibility that is supported by longitudinal research (Fergusson & Horwood, 1997; Kessler et al., 1995; Lynskey & Hall, in press). Nonetheless, it may also be the case that lower educational achievement increases the likelihood of cannabis use (Lynskey & Hall, in press). The association observed here probably reflects a combination of these factors.

Longitudinal research has also indicated that greater involvement with cannabis use at an early age increases the likelihood of unemployment for more than 3 months (Fergusson & Horwood, 1997). This finding has been supported by the current analyses of the NSMHWB sample, with those who were unemployed much more likely to be cannabis users, and to be more heavily involved with cannabis use, than those who were employed. Nevertheless, the current findings cannot elucidate any causal mechanisms underlying the association. The pattern here differed from that found in the ECA, where drug abuse/dependence were not associated with working for pay (Anthony & Helzer, 1991).

4.2 CANNABIS USE AND OTHER DRUG USE

The use of psychoactive substances was highly correlated in the Australian population. Those who reported using cannabis 5 times or less in the past 12 months ("non-users") were least likely to

report alcohol use or the use of sedatives, stimulants or opiates. As involvement with cannabis use increased, so too did the prevalence of other substance use.

A similar pattern was found when examining the likelihood of *regular* substance use or substance use disorders. Regular tobacco use was much more likely among cannabis users, with 20% of non-users reporting such use, compared to 50-70% of persons with some involvement with cannabis use. Similarly, cannabis use of any sort was strongly related to an increased prevalence of alcohol use disorders, with more than one in 3 of those who met criteria for either cannabis abuse or dependence (37%) also meeting criteria for an alcohol use disorder. Other drug use disorders were similarly related, with very few non-users of cannabis meeting criteria for a use disorder (0.5%), and the proportions increasing as involvement increased, with one in 6 cannabis-dependent persons having another drug use disorder (18%).

There was some attenuation of these relationships after accounting for the effects of demographics, neuroticism, and the use of other drug types. The association between cannabis involvement and all indicators of other substance use problems nonetheless remained highly significant. Regular tobacco use, alcohol use disorders, and other drug use disorders, were all related to involvement with cannabis independently of these other factors.

There are a number of possible reasons for this association. The first is that there is no causal relationship between cannabis use and other substance use, but that there are factors common to the use of different substances, which were not considered here, that are responsible for the association. For example, persons with higher numbers of risk factors such as poor parental relationships have been found to be more likely to use *all* drug types (Lynskey, Fergusson, & Horwood, 1998; Newcomb, Maddahian, & Bentler, 1986). Other factors such as religiosity (Kendler, Gardner, & Prescott, 1997a) have also been found to affect the likelihood of substance use and abuse.

Research also suggests that familial factors may increase the likelihood of substance abuse in general (Merikangas et al., 1998). Genetic vulnerabilities in particular have been implicated as increasing the likelihood of problematic substance use. Genetic factors have been implicated as increasing the likelihood of alcohol dependence (Kendler et al., 1994; Kendler et al., 1997b), cannabis dependence (Kendler & Prescott, 1998a), nicotine dependence (Kendler et al., 1999) and cocaine dependence (Kendler & Prescott, 1998b). It is possible that these vulnerabilities may be similar across other drug types, a finding that has been supported in an examination of nicotine and alcohol dependence (True et al., 1999).

Another view, the "gateway hypothesis", characterises what has been termed the "developmental sequence" of drug use (Kandel & Faust, 1975; Kandel, Davies, Karus, & Yamaguchi, 1986; Kandel, Yamaguchi, & Chen, 1992). This proposes that substance use progresses through stages, with progression to a higher stage made more likely by use of a drug at an earlier stage. The use of cannabis increases the likelihood of using other "harder" drugs. While this may describe the pattern in which drug use occurs, it does not preclude the possibility that other factors explain the reasons for this pattern.

Longitudinal research suggests that much of the association between the use of different drug types is not a simple association between the use of one drug and another, or of one predominant risk factor. Rather, it is better thought of as due to multiple risk factors that constitute a "pathway" in which drug use in general is made more likely, similar to the developmental pathway thought to typify childhood psychopathology (Sroufe, 1997). Early drug use, for example, has been found to increase the likelihood that adolescents will subsequently associate with delinquent peers and move out of home; these factors subsequently increase the likelihood of poor outcomes later on

(Fergusson & Horwood, 1997). One of these outcomes may be continued or escalated substance use (Newcomb & Bentler, 1988).

4.3 CANNABIS USE AND NEUROTICISM

Those who were cannabis users had significantly higher levels of neuroticism as measured by the EPQ, with average scores higher among those who met criteria for abuse and dependence. This is consistent with previous research showing that cannabis users had higher EPQ scores (Sieber & Angst, 1990; Wells & Stacey, 1976). The higher scores among those with cannabis dependence have also been found in a previous sample of cannabis-dependent persons (Bachman & Jones, 1979).

4.4 CANNABIS USE, DEPRESSION, AND ANXIETY

There was a strong univariate association between involvement with cannabis use in the past 12 months and the prevalence of DSM-IV affective and anxiety disorders. Among those with cannabis dependence, just over one in 7 met criteria for an affective disorder (14%), while 1 in 6 met criteria for an anxiety disorder (17%). In comparison, 6% of non-users met criteria for an affective disorder, and 5% met criteria for an anxiety disorder. These associations are consistent with the more general ECA findings of higher lifetime rates of affective and anxiety disorders among persons with lifetime drug use disorders (Anthony & Helzer, 1991).

Psychological distress and life satisfaction were also strongly related to involvement with cannabis on a univariate level. Those with increasingly higher involvement with cannabis reported greater levels of psychological distress (as measured by Kessler's Psychological Distress scale), greater limitations in the everyday lives due to emotional distress (as measured by the SF-12), and lower life satisfaction. These relationships are consistent with other research suggesting that cannabis users may have higher levels of psychological distress, anxiety and depression (Kandel et al., 1986; Milich et al., 2000; Troisi et al., 1998; Zablocki et al., 1991).

However, these relationships may be explained by other factors. When these relationships were examined while controlling for demographic characteristics, neuroticism and other drug use, only those who were cannabis dependent had significantly higher levels of psychological distress compared to non-users. There were no significant relationships between cannabis use and affective/anxiety disorders after controlling for the other factors examined here. In particular, it was after controlling for other drug use that these relationships disappeared. In other words, once the cannabis user's higher levels of other drug use (regular tobacco use, alcohol abuse/dependence, and other drug use) were taken in to account, there was no significant association between cannabis use and these disorders. It was the other drug use that accounted for the significant association between cannabis use, depression and anxiety. These findings suggest that there is no direct relationship between cannabis use and either affective or anxiety disorders.

4.4.1 CANNABIS USE AND DEPRESSION AND ANXIETY – HOW ARE THEY RELATED?

There has been recent public concern over the possibility that cannabis use, particularly among young persons, is in some way causally related to depression. The present report found that this

relationship did not appear to hold in the Australian adult population. Instead, it seemed to arise from the fact that cannabis users were more likely to meet criteria for an alcohol use disorder, smoke regularly, and use other drug types. It must be said that in including neuroticism as a predictor, we may be "overcontrolling" for this trait, since reported trait levels of neuroticism may be correlated with state levels of anxiety and depression. Even so, there was no significant relationship between cannabis and anxiety and affective disorders even if neuroticism was not included as a covariate.

However, because the relationship between cannabis use and other drug use did not disappear after controlling for other factors (see section 4.2), there may be an indirect relationship between cannabis use and depression. For example, dependent cannabis users might be more likely to develop other drug use problems as well, and this drug use might then increase the risk of depression. The present data do not allow an examination of this possibility. Future research might examine this possibility, for example, through longitudinal data. Prospective studies might examine the effect of reducing cannabis and other drug use on depression at a later point in time.

Some other indirect relationship could exist. For example, it may be that cannabis use at an early age increases the chances that educational attainment will be lower (Lynskey & Hall, in press). Poorer educational qualifications may limit a person's employment prospects, leading to depression. This is an instance in which the consequences of cannabis use affect another factor that has a direct relationship with depression. Alternatively, it may be that a different relationship exists: for example, having an anxiety disorder may affect the level of education attained, meaning that employment tends to be in less technical or demanding positions, which might make heavier involvement with cannabis easier to develop.

While there appears to be no direct relationship between cannabis use and these indicators of mental health, it is still the case that heavier involvement with cannabis use is *correlated* with these disorders. This has important clinical implications. Comorbid anxiety and affective disorders could affect the outcome of treatment for cannabis dependence. Research into interventions for cannabis dependence is a relatively recent phenomenon. There is evidence to indicate that cognitive-behavioural therapy may be effective in aiding dependent persons to address problematic cannabis use (Stephens, Roffman, & Simpson, 1994). There is a lack of literature examining possible interactions between comorbid mental health and substance use problems. Research examining the effect of comorbid mental disorders on treatment outcome, particularly as the rates of comorbidity in treated populations are likely to be higher than in the general population.

The high rate of comorbidity needs to be kept in mind by clinicians dealing with persons with cannabis use problems. Simple screening instruments could be used to examine whether a potential client may have other mental health issues that need addressing. Future research into interventions might involve a more comprehensive intervention targeting symptoms of depression and anxiety.

4.5 CANNABIS USE AND PSYCHOSIS

In the Australian adult population, persons who used cannabis were more likely to screen positively for psychosis, as determined by a screening questionnaire. Around one in 143 persons who were non-users screened positively, with the prevalence increasing as involvement with cannabis increased, such that one in 15 persons who met criteria for cannabis dependence also screened positively for psychosis. After controlling for demographics, neuroticism and other drug use, this relationship was still significant. This association is consistent with clinical research showing a high prevalence of cannabis use among persons with schizophrenia (Drake, Bartels, Teague, Noordsby,

& Clark, 1993; Drake & Wallach, 1989; Drake, Mueser, Clark, & Wallach, 1996; Fowler et al., 1998; Mueser et al., 2000), and with the findings of the ECA study of an association between schizophrenia and cannabis use and abuse (Anthony & Helzer, 1991; Cuffel, Heithoff, & Lawson, 1993)

There are a number of possible reasons for this association (Hall, 1998; McKay & Tennant, 2000). One is that persons with psychosis use cannabis in an effort to self-medicate unpleasant symptoms, due both to medication, and due to the symptoms of the disorder. This is plausible, however the reasons cited by persons with schizophrenia for their cannabis use tend to be similar to those cited by the remainder of the population (Hall, 1998; Hall & Degenhardt, 2000).

There is also a hypothesis that cannabis may play some sort of causal role with respect to precipitation of schizophrenia in vulnerable individuals. For example, there is evidence that the use of cannabis by age 18 years increases the risk of developing schizophrenia over the next 15 years (Andreasson et al., 1987). This association remained after controlling for psychiatric disorders at baseline and parental divorce (as an indicator of parental psychiatric status). This has led some to suggest that cannabis may play a role in precipitating schizophrenia among vulnerable individuals (Andreasson et al., 1987; Hall, 1998; Hall & Degenhardt, 2000; McKay & Tennant, 2000).

Cannabis use may also worsen the clinical picture of persons who have psychotic illnesses, by making symptoms worse, or by increasing the chronicity of the illness (Hall, 1998; Hall & Degenhardt, 2000). Prospective studies of persons with psychosis have suggested that cannabis use predicts relapse to psychotic symptoms among persons with psychotic disorders (Jablensky, Sartorius, & Ernberg, 1991; Linszen, Dingemans, & Lenior, 1994). In the case of the Linszen et al. study, other substance use (including alcohol) was controlled (Linszen et al., 1994). Replications of these findings are needed. Controlled outcome studies of substance abuse treatment for persons with psychosis are also needed to see whether cessation of drug use predicts improvement in psychotic symptoms (Hall, 1998). Future work might also be aimed at developing effective interventions for persons with psychotic illnesses who use cannabis, to assist them to reduce or cease their cannabis use.

The present findings reinforce the need for dissemination of the potential mental health risks of cannabis use. This might include more information provided to young persons on the mental health risks of cannabis use. This might include identification of signs that characterise such illnesses. Information might also be given to persons who are at greater risk of developing psychosis (e.g. those with a family history of the illness) about the possibility that cannabis use may increase their risk of developing the disorder.

4.6 CONCLUSIONS

There is a strong relationship between the level of cannabis involvement, and both drug use problems and mental health problems. In the case of drug use, the association was not accounted for by demographic factors, neuroticism, or other drug use. From the present data, it is not possible to identify the nature of the relationship between cannabis use and other drug use problems. However, given the existing literature, it appears that early initiation to cannabis use may increase the likelihood of other factors such as poor school performance and selection into peer groups that may affect the likelihood of other drug use. The high prevalence of other drug use problems among persons with problematic cannabis use in the general population suggests that other drug use may need to be considered when persons request treatment for cannabis use

problems.

The correlations between cannabis involvement and mental disorders appeared to be explained by demographics, trait neuroticism, and other drug use. This suggests that there is no direct causal relationship between the use of cannabis and mental health. Although we may be "overcontrolling" for trait neuroticism, since reported trait levels of neuroticism may be correlated with state levels of anxiety and depression, there was no significant relationship with anxiety or affective disorders when neuroticism was left out of the model. This finding does not exclude the possibility that an indirect causal relationship exists, for example, if cannabis use meant that problematic use of other drugs was more likely, which then increased the risks of depression and anxiety.

Regardless of the reasons for the relationship, there was a high prevalence of anxiety and affective disorders among persons with greater involvement with cannabis use. This may be an important factor to consider in treatment for cannabis dependence, and in the treatment of depression in young adults. Future work needs to examine the effect of other mental health problems upon treatment for cannabis dependence, as well as investigating more comprehensive therapies for persons wishing to address their cannabis use problem.

In the general population, many of those with cannabis use disorders will have other mental health problems, which is important given the increase in the numbers presenting to treatment agencies for help with their dependent cannabis use (Conroy & Copeland, 1998). This is especially important given that those with cannabis dependence who also met criteria for another mental disorder were substantially more likely to seek help for a mental health problem. This means that people coming to the attention of treatment services will be much more likely to have multiple problems; these need to be considered and addressed in treatment.

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APPENDIX A

Table A1: Odds ratios (OR) and 95% confidence intervals (95%CI) for drug use according to cannabis use, adjusted for demographics (OR – 1); and demographics and other drug use (OR – 2)

	OR - 1[1]	95%CI – 1	OR - 2[1]	95%CI – 2
Regular tobacco use				
Cannabis use	3.45	2.85, 4.18	3.08	2.53, 3.74
Cannabis abuse	3.56	2.21, 5.73	2.82	1.73, 4.57
Cannabis dependence	5.70	3.92, 8.24	4.52	3.09, 6.61
Alcohol use				
Cannabis use	4.62	3.17, 6.75	3.87	2.59, 5.53
Cannabis abuse	3.56	1.41, 9.03	3.00	1.19, 7.61
Cannabis dependence	1.86	1.14, 3.00	1.40	0.86, 2.29
Alcohol use daily				
Cannabis use	2.39	1.89, 3.00	2.01	1.59, 2.54
Cannabis abuse	2.38	1.38, 4.14	1.98	1.14, 3.45
Cannabis dependence	1.68	1.05, 2.71	1.28	0.79, 2.08
Alcohol use disorder				
Cannabis use	3.29	2.56, 4.22	2.24	1.72, 2.92
Cannabis abuse	5.61	3.41, 9.21	3.90	2.34, 6.53
Cannabis dependence	5.41	3.71, 7.90	2.96	1.98, 4.42
Other drug use				
Cannabis use	5.91	4.35, 8.00	4.60	3.35, 6.30
Cannabis abuse	5.53	2.75, 11.13	3.58	1.74, 7.37
Cannabis dependence	11.59	7.46, 17.78	7.73	4.90, 12.18
Other drug use disorder				
Cannabis use	5.15	2.77, 9.55	3.25	1.72, 6.17
Cannabis abuse	6.62	1.92, 22.87	3.49	1.00, 12.30
Cannabis dependence	29.67	16.23, 54.54	16.12	8.48, 30.27

1. All odds ratios use "no cannabis use" group as the reference category

Table A2: Odds ratios (OR) and 95% confidence intervals (95%CI) of DSM-IV affective and anxiety disorders according to cannabis use, adjusted for demographics (OR – 1); and demographics and other drug use (OR – 2)

	OR - 1[1]	95%CI – 1	OR - 2[1]	95%CI - 2
DSM-IV affective disorder				
Cannabis use	2.11	1.61, 2.77	1.25	0.93, 1.68
Cannabis abuse	2.75	1.50, 5.04	1.53	0.81, 2.89
Cannabis dependence	2.44	1.56, 3.81	1.07	0.66, 1.73
DSM-IV anxiety disorder				
Cannabis use	1.62	1.18, 2.23	0.88	0.62, 1.24
Cannabis abuse	0.94	0.37, 2.38	0.47	0.18, 1.22
Cannabis dependence	3.49	2.27, 5.35	1.51	0.95, 2.40

1. All odds ratios use "no cannabis use" group as the reference category

Table A3: Results of linear regression of cannabis use on measures of mental health and well-being, adjusted for demographics

	Standardised beta coefficient[1]	Regression coefficient[1]	95%CI	t (sig)
GHQ				
Cannabis use	0.03	0.31	0.13, 0.49	3.31 (<.005)
Cannabis abuse	0.02	0.53	0.08, 0.97	2.30 <.05)
Cannabis dependence	0.06	0.94	0.62, 1.27	5.68 (<.001)
Delighted-terrible				
Cannabis use	0.03	0.13	0.04, 0.23	2.66 (<.01)
Cannabis abuse	0.03	0.35	0.10, 0.59	2.80 (<.005)
Cannabis dependence	0.06	0.58	0.40, 0.76	6.41 (<.001)
Kessler's PD				
Cannabis use	-0.05	-1.24	-1.72, -0.77	-5.14 (<.001)
Cannabis abuse	-0.03	-1.81	-2.98, -0.65	-3.05 (<.005)
Cannabis dependence	-0.08	-3.55	-4.40, -2.70	-8.21 (<.001)
SF-12				
Cannabis use	-0.05	-2.33	-3.19, -1.47	-5.32 (<.001)
Cannabis abuse	-0.04	-3.96	-6.07, -1.86	-3.69 (<.001)
Cannabis dependence	-0.08	-6.44	-7.97 ,-4.91	-8.24 (<.001)

1. All coefficients are estimates of the change from "no cannabis use" group as the reference category

Table A4: Results of linear regression of cannabis use on measures of mental health and well-being, adjusted for demographics and other drug use

	Standardised beta coefficient[1]	Regression coefficient[1]	95%CI	t (sig)
GHQ				
Cannabis use	0.01	0.05	-0.14, 0.23	ns
Cannabis abuse	0.01	0.19	-0.26, 0.63	ns
Cannabis dependence	0.03	0.47	0.14, 0.80	2.81 (<.01)
Delighted-terrible				
Cannabis use	-0.01	-0.04	-0.14, 0.06	ns
Cannabis abuse	0.01	0.12	-0.12, 0.37	ns
Cannabis dependence	0.03	0.29	0.11, 0.46	3.69 (<.005)
Kessler's PD				
Cannabis use	-0.01	-0.13	-0.60, 0.35	ns
Cannabis abuse	-0.01	-0.33	-1.47, 0.82	ns
Cannabis dependence	-0.03	-1.54	-2.38, -0.70	-3.58 (<.001)
SF-12				
Cannabis use	-0.02	-0.68	-1.54, 0.18	ns
Cannabis abuse	-0.02	-1.79	-3.87, 0.30	ns
Cannabis dependence	-0.04	-3.49	-5.02, -1.95	-4.45 (<.001)

1. All coefficients are estimates of the change from "no cannabis use" group as the reference category

Table A5: Odds ratios (OR) and confidence intervals (95%CI) of screening positively for psychosis according to cannabis use, adjusted for demographics (OR – 1); and demographics and other drug use (OR – 2)

	OR - 1[1]	95%CI – 1	OR - 2[1]	95%CI - 2
Psychosis screen +				
Cannabis use	2.88	1.60, 5.21	1.48	0.97, 2.75
Cannabis abuse	3.39	1.00, 11.47	1.87	0.54, 6.49
Cannabis dependence	7.39	3.74, 14.59	3.11	1.51, 6.40

1. All odds ratios use "no cannabis use" group as the reference category