

Marijuana: An Overview of the Empirical Literature

Michael J. Zvolensky, Marcel O. Bonn-Miller, Teresa M. Leyro,
Kirsten A. Johnson, and Amit Bernstein

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Introduction

Marijuana (also referred to as cannabis) is a drug that is derived from the flowers, stems, leaves, and seeds of the hemp plant (*Cannabis sativa*). The need for public health awareness and evidence-based clinical care for marijuana use and its disorders remains a major health care priority in the United States and beyond. Indeed, marijuana has been the most widely used illicit substance in the United States for the past 30 consecutive years [66], with approximately 25 million people in the United States (8.6% of the population) having used marijuana in the past year [67]. An estimated 10% of persons who have ever used marijuana will become daily users [64]. Lifetime marijuana dependence is estimated at 4% of the general population, a rate that is the highest of any illicit drug [3, 4]. These rates of marijuana use, abuse, and dependence in the United States represent a significant public health concern considering that several well-documented negative consequences have been associated with daily or weekly drug use (e.g., increased risk of severe medical disease, increased risk taking behavior, and clinically significant life impairment) [9, 81, 109].

The overarching aim of the present chapter is to provide an overview of marijuana use and its disorders. The chapter is organized into seven sections. First, we describe the prevalence of marijuana use and its disorders. Second, we clarify the nature of marijuana use in terms of its pharmacokinetics and acute intoxication features. In the third section, we describe the

M.J. Zvolensky (✉)
Department of Psychology, University of Vermont,
Burlington, VT, USA
e-mail: michael.zvolensky@uvm.edu

classification of marijuana use and its disorders using the current diagnostic nomenclature. Fourth, we describe the motivational bases for use of the drug. In the fifth section, we provide a synopsis of some problems associated with marijuana use and its disorders, including health problems, social problems, and psychological disturbances. Sixth, we provide a summary of the scientific work focused on marijuana, the reasons for its use, and users' relative success in quitting. In the final section, we describe some practically oriented clinical issues for primary care medical practitioners to consider in terms of the recognition and treatment of marijuana use and its disorders.

Prevalence

Marijuana has been the most widely used illicit substance for 30 consecutive years in the United States [65], with approximately 25 million people in the United States (8.6% of the population) having used marijuana in the past year [67]. An estimated 10% of persons who have ever used marijuana will become daily users [64]. Lifetime marijuana dependence is estimated at 4% of the general population, a rate that is the highest of any illicit drug [3, 4]. Rates of conditional dependence, defined as the risk for developing dependence among those who have ever used the drug, indicate that marijuana is associated with a high rate of dependence potential [4]. For example, the relative risk of experiencing marijuana dependence given use of the drug in the past year is estimated to be 7% among adults, which is only slightly lower than that for cocaine (12%) and greater than that observed for alcohol (5%) [69]. Furthermore, greater levels of use are related to an increased risk for dependence. Studies suggest that the rate of dependence is 20%-30% among those persons using marijuana on a regular (weekly) basis [49]. Moreover, marijuana use problems have increased in certain parts of the world, with 35% of adult marijuana users in the United States currently meeting criteria for marijuana abuse or dependence,

compared with 30% 10 years earlier, representing an increase of approximately 730,000 individuals [26].

Of special relevance to clinical practitioners, many treatment and community studies have examined prevalence rates of marijuana use among different samples suffering from a variety of medical and psychological problems. For example, one study found that among those seeking treatment for psychosis, approximately 23% currently used marijuana, with about half of that group currently "misusing" the drug [47]. This study examined the "misuse" of marijuana rather than abuse or dependence. As a result, the precise percentage of those abusing or dependent on marijuana in this study is not known. Another community-based study found that approximately 16% of those with spinal cord injury used marijuana [117]. Other work found that marijuana use accounted for as much as 25% of the primary drug problems of individuals seeking residential drug treatment [38]. Similarly, among adolescents seeking outpatient services for marijuana abuse or dependence, approximately 38% reported suffering from depression and 29% reported acute levels of anxiety [37]. These studies suggest that marijuana use: (1) may be overrepresented among certain "vulnerable" populations and (2) is a primary clinical concern.

Nature of Marijuana Use: Pharmacokinetics and Acute Intoxication Features

Pharmacokinetics

Marijuana can be consumed via smoking (e.g., hand-rolled cigarettes, water pipes, non-water pipes) or ingestion (e.g., mixed into foods or used in the process of brewing tea). Marijuana shares some qualities with tobacco in that it is composed principally of plant material, often is used via smoking routes (e.g., pipes, joints), and contains a myriad of chemical compounds. Unlike tobacco, however, the active

agents in marijuana are cannabinoids (unique to the marijuana plant). There are at least 60 different cannabinoids in marijuana, although the pharmacokinetics of the vast majority of these compounds is largely unknown [6]. Of these, the most well-known, and arguably important, cannabinoid is tetrahydrocannabinol, which is believed to be the most potent psychoactive agent in the cannabinoid plant [110]. The tetrahydrocannabinol content of plants from a range of sources and strains varies dramatically [86]. With a focus on improved plant breeding and improved growing techniques, the tetrahydrocannabinol content of marijuana has increased dramatically in a short period of time. As one illustrative example, tetrahydrocannabinol content from a typical marijuana cigarette (joint) in the 1960s was 10 mg, whereas estimates suggest that it currently is around 1 g (or 150–200 mg) [6]. Given that marijuana effects are dose dependent (i.e., greater amount or potency yields greater effect) [110], the significantly increased potency of marijuana available in the current time period relative to the past is a major public health concern and is important to understanding the current and historical prevalence rates of use, abuse, and dependence.

Since the discovery of a cannabinoid receptor within the brain in the late 1980s, researchers have been able to explicate the process by which tetrahydrocannabinol acts on the brain. Currently, there is evidence of three potential cannabinoid receptors, only one of which is located within the brain (the cannabinoid-1 receptor) [110]. When tetrahydrocannabinol is inhaled into the body via marijuana smoking, it passes from the lungs into the bloodstream [56]. Once in the blood, tetrahydrocannabinol attaches to cannabinoid receptors, such as the cannabinoid-1 receptor, adding to or reducing the naturally occurring endogenous ligands for these receptors (e.g., anandamide) [36]. The cannabinoid-1 receptor, in particular, has been found to mediate both neurochemical and behavioral properties of these cannabinoids including tolerance [110]. It also is noteworthy that tetrahydrocannabinol and other cannabinoids move rapidly into fat and other bodily

tissues but are relatively slowly released from these tissues back into the bloodstream [61]. Eventually, cannabinoids are cleared from the body via urine and fecal matter [110].

Acute Intoxication Features

In general, marijuana consumption produces a mild, relatively short period of intoxication (being “high”). More specifically, marijuana can produce a range of acute psychosensory experiences including perceptual distortions (e.g., hallucinogenic properties), relaxation, anxiety, acute paranoia, inhibition, and so on [63]. Periods of intoxication depend on use patterns and potency, but tend to last for at least a few hours [21, 87, 91]. Marijuana intoxication also impairs cognitive and psychomotor performance with complex, demanding tasks [50, 98]. There is a dose-dependent relation between marijuana use and psychomotor and cognitive impairment, with higher doses being associated with more impairment for more demanding tasks [6, 50]. Although cognitive impairment for hours after using marijuana is a well-replicated phenomenon in laboratory studies [98], there has been consistent debate about the permanent cognitive effects of using marijuana [6]. Some recent work suggests that individuals who have used marijuana over long periods of time demonstrate impaired performance on a variety of neuropsychological tests (e.g., attention, memory, and processing complex information) even when not acutely intoxicated [51]. These negative cognitive effects appear to be present months and even years after successful cessation [98]. Overall, pre-existing cognitive deficits or disease may be exacerbated or complicated by regular marijuana use.

Classification of Marijuana Use and Its Disorders

The current diagnostic criteria for problematic patterns of marijuana use, according to the *Diagnostic and Statistical Manual of Mental*

Table 1 Criteria for marijuana abuse

A. A maladaptive pattern of substance use, leading to clinically significant impairment or distress, as manifested by one (or more) of the following, occurring within a 12-month period:
1. Recurrent substance use resulting in a failure to fulfill major role obligations at work, school, or home.
2. Recurrent substance use in situations in which it is physically hazardous.
3. Recurrent substance-related legal problems.
4. Continued substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance.
B. The symptoms have never met the criteria for marijuana dependence.

Table 2 Criteria for marijuana dependence

A maladaptive pattern of substance use, leading to clinically significant impairment or distress, as manifested by three (or more) of the following, occurring at any time in the same 12-month period [2]:
1. Tolerance, as defined by either of the following:
(a) a need for markedly increased amounts of the substance to achieve intoxication or desired effect
(b) markedly diminished effect with continued use of the same amount of the substance
2. Withdrawal, as manifested by either of the following:
(a) the characteristic withdrawal syndrome for the substance
(b) the same (or closely related) substance is taken to relieve or avoid withdrawal symptoms
3. The substance is often taken in larger amounts or over a longer period than was intended.
4. There is a persistent desire or unsuccessful efforts to cut down or control substance use.
5. A great deal of time is spent in activities necessary to obtain the substance, use the substance, or recover from its effects.
6. Important social, occupational, or recreational activities are given up or reduced because of substance use.
7. The substance use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance.

Disorders, 4th edition, include abuse and dependence [2] (see Tables 1 and 2 for the diagnostic criteria for marijuana abuse and marijuana dependence, respectively). Marijuana abuse is a pattern of marijuana use that includes significant and unpleasant consequences associated with frequent use. This pattern needs to have occurred within a 12-month period. Some of the consequences associated with marijuana abuse include multiple legal problems, repeated use in physically hazardous situations, and recurrent social and interpersonal problems as a result of use. What differentiates substance abuse from dependence is that abuse only includes harmful consequences of frequent use, whereas dependence indicates compulsive use, tolerance, or withdrawal [2]. As with diagnosis of other substance use disorders, it is also important to note that marijuana abuse cannot be diagnosed if marijuana dependence criteria are met. This important distinction highlights the putative more severe nature of marijuana dependence.

There are relatively few empirical data, however, pertaining to the validity of distinguishing among marijuana use, abuse, and dependence [48]. Moreover, for a long period of time, scholars did not uniformly endorse or support a marijuana dependence syndrome [16]. Current research has partially laid these earlier questions to rest in that heavy users of the drug tend to report problems controlling their use, despite noted negative consequences, and experience withdrawal and other adverse symptoms when discontinuing use (see [51] for a review). In fact, the best estimates suggest that approximately 1 out of every 10 individuals who use the drug become dependent on it at some point in the future [4], a pattern of data consistent with alcohol use problems, but markedly lower than that found with tobacco [4].

To date, researchers have employed standardized interviews to index marijuana diagnoses in a manner identical to those for other types of substances (e.g., alcohol, tobacco). At the

same time, in contrast to the relatively recent emerging perspective that classification of marijuana along the nosological lines of use, abuse, and dependence is the optimal and most accurate approach [16], it has been more common historically to denote marijuana use variability by asking respondents to indicate their level of use (e.g., frequency) over a specified period of time [33]. From this perspective, having participants specify the frequency, and perhaps quantity, of marijuana use also can be a common assessment method [24]. Collectively, then, deciding upon whether nosological classification and/or a use-oriented assessment protocol (i.e., volume and frequency) is indicated may depend on the specific clinical need or research question being posed and the theoretical basis for it.

Motivational Bases of Marijuana Use

Researchers and clinicians also have increasingly found merit in applying motivational models to understand and clinically intervene with marijuana use and its disorders. This work has built from the motivational study of alcohol [28, 31, 106, 107] and tobacco [62, 88, 90, 120] use. At the most basic level, such an approach recognizes that there are a number of distinct motives for using marijuana that can vary both between and within individuals [27]. That is, two individuals may use marijuana for different reasons, and one individual may use for multiple types of reasons. Motivational models predict that distinct motives may theoretically be related to particular types of problems [27]. For example, specific motives may play unique roles in various aspects of use (e.g., addictive use, withdrawal symptoms, craving) or problems related to use (e.g., psychological disturbances, risk-taking behavior). Thus, enhancing efforts to explicate marijuana use motives empirically will presumably facilitate, as it has for alcohol and tobacco use [27, 88], the nature of marijuana use and its disorders as well as linkages between marijuana use and its clinically important correlates.

Recognizing the practical importance of theoretically delineating and empirically measuring marijuana use motives, Simons and colleagues developed the Marijuana Motives Measure [96, 97]. Studies have evaluated the factor structure of the Marijuana Motives Measure: one focused on young adults in the United States ($n = 161$ [97]); one focused on young adults and adolescents in France ($n = 114$ [22]), and the most recent one focused on young adult marijuana users in the United States ($n = 227$ [122]). Using a combination of exploratory factor analytic and confirmatory factor analytic approaches, the Marijuana Motives Measure demonstrated a multidimensional measurement model across extant work—specifically, a five-factor solution denoting Enhancement, Conformity, Expansion, Coping, and Social motives for marijuana use, each with satisfactory levels of internal consistency [22, 97, 122].

Existing motivation-oriented work on marijuana is important in terms of informing the understanding of how and why marijuana use may be related to certain patterns of substance use and psychological problems. For example, greater levels of Coping, Enhancement, Social, and Expansion motives for marijuana use have each been found to be concurrently significantly associated with frequency of past-30-days marijuana use [10, 22, 96, 97]. These associations between motives for use and frequency of use do not appear to be attributable to other alternative factors such as amount of time being a marijuana user or other types of concurrent substance use [10]. However, the exact directional relation between marijuana motives and patterns of marijuana use remains underexplored. For example, it is not known whether specific marijuana motives explain variance in marijuana use patterns when controlling for the shared variance with other motives (e.g., the explanatory value of coping motives when controlling for shared variance with other marijuana use motives). Still, it is noteworthy that other work suggests that specific motives may be relevant to the understanding of psychological vulnerability. For example, coping motives for marijuana use, but not other motives, have been significantly predictive of

negative affect, anxious arousal, and anhedonic depressive symptoms [83]. These types of findings may have important theoretical implications for a better understanding of previous research linking marijuana use to affect-based psychological vulnerability.

Negative Correlates of Marijuana Use and Its Disorders

Historically, marijuana has been viewed by some as a “less severe” or “soft” drug [100]. In contrast, scientific study has provided a corpus of empirical evidence that marijuana use and its disorders are associated with a number of clinically significant problems [68]. Indeed, there are several empirically documented negative consequences of frequent or problematic marijuana use (typically defined as weekly or daily use). These negative effects are evident in physical, social, interpersonal, and, more recently, psychological realms. In this section of the chapter, we describe some examples of work pertaining to possible negative correlates of marijuana use.

Health-Related Problems

Perhaps the foremost negative effect linked to various types of marijuana use is its impact on physiological processes, particularly the cardiovascular and pulmonary systems. On the one hand, as would be expected, many of these effects are similar to those typically found with tobacco. On the other hand, due to the potentially greater level of carcinogenic properties of marijuana relative to tobacco [99], among certain subpopulations of users (e.g., those using marijuana more frequently), the negative medical effects of this drug are, perhaps, even more clinically noteworthy. For example, frequent marijuana use is associated with increased risk of severe respiratory illnesses, especially chronic bronchitis [9]. Other work has shown that when

compared with individuals who do not use marijuana or tobacco, or with tobacco smokers who have no marijuana use history, the lung function of those who use marijuana regularly is significantly poorer [41].

There also has been a series of important large-scale prospective studies documenting the negative effects of marijuana over time on pulmonary functioning (e.g., [94, 111, 112]). Though the results across investigations are not fully consistent, they converge on the observation that greater duration of marijuana use is related to increased bronchitis symptoms (e.g., coughing, wheezing [111]). There also are studies of the relations between marijuana use and cancer. Most investigations suggest that there is an increased risk of lung cancer among more frequent users of the drug [20]. Controlled studies of these cancer-related negative effects of marijuana use, however, are largely underrepresented in the literature. In addition to the increased risk for lung cancer, it is noteworthy that some research suggests that marijuana use may be related to impaired immune system functioning, but these investigations, again, have not been consistently replicated [25, 58, 71]. Upon close inspection of these studies, it becomes clear that some of the inconsistencies of these investigations may be related to problems in the measurement of marijuana use and individual differences in use. A similar set of issues is evident for linkages between marijuana use and impaired reproductive effects. Non-human research suggests that heavier marijuana use is related to impaired reproduction capacity [51], but controlled evidence among humans is currently lacking [20].

It should be noted that although the vast majority of research has focused on elucidating putative negative health consequences or correlates of marijuana use, there has been scientific and clinical interest in possible health benefits of the drug. Namely, marijuana has been suggested to improve certain disease symptoms (e.g., by decreasing eye pressure, involuntary movement, and perceived pain) and to stimulate appetite [57, 58]. Although this body of work is complicated, the strongest evidence of possible health

benefits for marijuana use appears to be focused on increasing appetite, decreasing nausea and vomiting, preventing systemic weight loss, and possibly improving pain tolerance [58].

Social Problems

In addition to the potential risk of a number of negative physical consequences, adverse social consequences related to certain types of marijuana use have been reported (e.g., frequent users such as those who use on a daily or weekly basis). Lynskey and Hall [78], for example, reviewed evidence suggesting that marijuana use was a contributing factor to impaired educational attainment, and others have found that marijuana use leads to reduced workplace productivity [74], as well as impaired judgment within hours after marijuana use (e.g., among airline pilots [75]). In all of these studies, a consistent pattern emerges: the greater the amount of use (measured in frequency of use or severity of use), the greater the impairment. The specific mechanism(s) underlying these use-related effects are as yet theoretically and empirically unspecified.

As another example, marijuana use has been shown to be related to other social problems. For example, one cross-sectional study found that those who are dependent on marijuana compared with those who are not demonstrate greater levels of clinically significant impairment in life activities (e.g., work or school performance [103]). Additionally, quantity of marijuana use and acute intoxication have been related to general risk-taking behavior and impaired judgment. For instance, marijuana use has been linked to fatal traffic accidents and general driving impairment [40], even after statistically controlling for the variance accounted for by alcohol use [43]. Other work suggests that frequent or more severe marijuana use may lead to using more severe forms of other drugs (e.g., widely publicized, but sometimes controversial, “gateway theories” of the developmental nature of substance use patterns) [85]. One overarching limitation to the vast majority of work linking certain

types of marijuana use to social and interpersonal functioning, and even future use of other substances, is that there is a dearth of (controlled) prospective evaluations. Thus, conclusions drawn from extant work should be viewed conservatively.

Psychological Problems

There have been a variety of psychological problems associated with marijuana use and its disorders. Perhaps the most well-known psychological problem(s) associated with marijuana use and its problems has been psychotic-spectrum disorders. There are numerous lines of empirical evidence that have provided robust evidence of an association between marijuana use and psychotic-spectrum disorders. Indeed, case reports of marijuana use have documented that such drug use can precede the onset of certain psychotic-spectrum disorders such as schizophrenia at higher rates than expected by chance of psychosis among “regular” marijuana users [11]. Although the directional nature of the marijuana-psychotic-spectrum problem association has been the subject of consistent intellectual debate (e.g., [52]), one position has been that the use of marijuana may actually increase the risk of psychotic-spectrum disorders [11]. Consistent with this marijuana-to-psychotic symptoms/disorders perspective, the acute effects of marijuana use have been found to contribute to the elicitation of psychotic episodes and exacerbations of such symptoms among previously afflicted persons (e.g., the recurrence of psychotic symptoms [80]). Other work has found that intravenous tetrahydrocannabinol administered to antipsychotic-treated patients with schizophrenia and non-psychiatric controls exacerbated positive schizophrenic symptoms in the patient sample and induced positive symptoms in controls [39]. Neuroimaging studies also have found similarities between neural networks impaired by marijuana use and those known to be implicated in the etiology of schizophrenia (see [77] for a review). Finally, in

a meta-analytic review of the existing empirical literature, Semple and colleagues [93] concluded that the early use of marijuana increased the risk of schizophrenia or a schizophrenia-like psychotic illness by approximately three-fold. Although a model indicating that marijuana may lead to psychotic-spectrum disorders provides only one possible way in which these factors may be related, it documents the importance of understanding marijuana in the context of severe mental illness.

In another area of research, scientific activity has been focused on addressing marijuana's relationship to depressive symptoms or problems [46]. The interest in this line of inquiry appears to have been historically fueled by the clinical observation that regular (e.g., on a daily or weekly basis) marijuana users often reported a "lack of motivation" for completing day-to-day activities (e.g., going to school [115]). The depression-marijuana literature has sometimes identified statistically significant relations between marijuana use and depressive symptoms and disorders [23]. However, the most recent work in this domain has indicated that the strength of such marijuana-depressive associations may be relatively weak, and markedly attenuated, or even nonexistent, after controlling for "common" variables such as gender [34]. As one illustrative example, Brook and colleagues [13] completed a study that involved a two-time (1- to 2-year interval) prospective study of Colombian adolescents ($n = 2,226$; 48.2% female) who were 12–17 years old. Findings indicated that marijuana use in early adolescence did not significantly predict later depressive symptoms (time 2) after controlling for distress and interpersonal functioning in earlier adolescence (time 1). This work, when considered in the context of the psychotic-spectrum research, noted earlier highlights that marijuana should not be considered to have the same types of linkages with all forms of mental illness.

Another stream of more recent work has begun to address the relations between marijuana use and anxiety symptoms and disorders. This work was initially stimulated by the observation that marijuana use may acutely promote

heightened levels of anxiety symptoms and elicit panic attacks under certain conditions or among certain individuals [57, 113, 115]. For example, when a person is intoxicated from using marijuana, they may experience acute paranoia, escalating anxiety symptoms, and perhaps a panic attack. This type of experience makes intuitive sense in that marijuana can elicit a wide range of acute sensory-oriented experiences and distortions that may be perceived as out of the person's control and could be interpreted as threatening by some persons fearful of such internal stimuli and experiences. Some evidence appears consistent with this perspective. For example, Hathaway [55] found that among weekly users of marijuana ($n = 104$), approximately 40% reported having had at least one panic attack related to such use. These prevalence rates are noteworthy in light of lifetime rates of panic attacks among the general population of approximately 5–8% [72]. Another study found that, after covarying cigarettes per day, alcohol use, and negative affectivity, the interaction between marijuana use and anxiety sensitivity (fear of anxiety and related internal sensations) is related to increased levels of anxiety symptoms among marijuana users who also use tobacco [119]. Thus, certain individual differences such as anxiety sensitivity may be important to consider in understanding the linkages between marijuana use and anxiety states and disorders.

Another study involving a representative sample ($n = 4,745$) found that a lifetime history of marijuana dependence, but not use or abuse, was related to an increased risk of panic attacks after covarying the effects of polysubstance use, alcohol abuse, and demographic variables [118]. In a more recent investigation, Zvolensky and colleagues [121] prospectively evaluated marijuana use, abuse, and dependence in relation to the onset of panic attacks and panic disorder. Participants at the start of the study were adolescents ($n = 1,709$) with a mean age of 16.6 years ($SD = 1.2$; time 1) and were reassessed 1 year later (time 2) and then again as young adults (time 3; mean age = 24.2 years, $SD = 0.6$). Results indicated that adolescent-onset marijuana use and dependence were significantly

prospectively associated with increased odds for the development of panic attacks and panic disorder. However, marijuana use or dependence was not *incrementally* associated with the development of panic after controlling for daily cigarette smoking. These recent findings underscore the importance of considering the role of cigarette smoking in the context of marijuana use in regard to understanding panic vulnerability.

Marijuana: Motivation to Quit, Reasons for Quitting, and Success in Quitting

Though historically and presently presumed by some key segments of the general public to be “relatively harmless” [5], it is important to point out that marijuana has many cardinal features of addiction similar to more “hard drugs”. Indeed, for many individuals who use marijuana, tolerance to the drug develops and, presumably, contributes to more frequent or heavier use patterns or dosing with more potent (“more pure tetrahydrocannabinol”) forms of the drug [50]. For example, non-human research and, more recently, a smaller human empirical database suggest that marijuana discontinuation among regular users produces an internally consistent withdrawal pattern (see [17] for a review). Disrupted sleep, nightmares, nausea, anxiety, tension, irritability, sweating, and chills are common withdrawal symptoms [15, 18, 17, 53]. Many of these symptoms appear early after drug discontinuation [18], and some may last for weeks beyond the quit day (e.g., disrupted sleep [18, 17]). This withdrawal profile can appear relatively quickly during the course of use (e.g., relative early in the marijuana using career [14, 29, 103, 101]) and may have clinical importance in terms of predicting relapse [19], although current data are not yet developed enough to yield conclusions in this regard. With the recognition that marijuana use and its disorders are common addictive behaviors and can be related to life impairment and a variety of related negative consequences, it is natural to question how

motivated users are to quit, what their reasons are for quitting, and what their relative degree of success is in doing so?

Motivation to Quit

Two bodies of empirical evidence indicate that a large number of individuals who use marijuana on a regular basis (e.g., monthly) and who meet a range of diagnostic criteria (from use through dependence) are motivated to quit. The first literature has evaluated treatment-seeking behavior. Here, the Drug Abuse Reporting Program [92] and other reports [95] first documented that a clinically significant number of individuals were seeking therapeutic services for problematic marijuana use. Other large-scale surveys independently replicated such findings [42, 59]. Dennis and colleagues [35] reported that of “the 1.5 million adult admissions to the U.S. public treatment system in 1998, 35% were admitted for treatment of marijuana problems” (p. 9). Such rates are higher than those found for cocaine (32%), opioids (18%), stimulants (9%), and other psychoactive substances (12%) [35]. Additionally, other reports involving national databases have found that the demand for treatment of marijuana use and its disorders doubled between 1992 and 1998 [108]. It also is important to note that marijuana treatment outcome studies have documented that a large number of treatment-seeking marijuana users are *not* current polysubstance abusers [100, 102]. For example, Stephens and colleagues [103] found that 80% of a large, marijuana-dependent sample ($n = 309$) did not report abuse of other substances in the past 90 days and 40% reported never abusing an illicit drug other than marijuana. These data indicate that marijuana represents a significant clinical and public health problem in its own right and commonly prompts treatment-seeking behavior even in the absence of other drug use.

The second body of evidence related to motivation to quit suggests that, despite the notable rates of documented treatment-seeking behavior,

most persons using, abusing, or dependent on marijuana actually attempt to quit on their own [30, 32, 116]. Self-quit behavior is operationally defined as attempts to quit without professional assistance (i.e., enrolling in a formal treatment program that uses pharmacological, psychosocial, or combined therapeutic approaches) [30]. Numerous studies have reported that by young adulthood, many individuals have made multiple marijuana quit attempts on their own. It also is noteworthy that rates of self-quit attempts from marijuana are generally similar to those observed for other substances (e.g., tobacco) [60]. For example, studies of weekly marijuana users have indicated that by age 30, individuals have reported a range of 3–7 quit attempts on their own (e.g., [30, 103]). Although some of these unsuccessful quitters may ultimately seek professional treatment when they continue to fail in their quit efforts, it is not presently clear what percentage will ultimately do so and under what circumstances.

These data are noteworthy for two chief reasons. First, these data suggest that a large proportion of marijuana-abusing or -dependent individuals are interested in and pursue quitting on their own. Second, there is little empirical knowledge about the phenomenology of these quit attempts (e.g., latency to lapse and relapse, withdrawal symptoms) or the mechanisms underlying success or failure in quit attempts among self-quitters not seeking professional treatment. Such knowledge is essential for understanding malleable processes underlying marijuana lapse and relapse versus sustained abstinence and, therefore, will ultimately facilitate future translational efforts to develop innovative marijuana treatment strategies targeting those at high risk for relapse.

Reasons for Quitting

Current marijuana users, ranging from monthly users to those dependent on the drug, report multiple concurrent reasons for quitting [45, 79, 103, 116]. Among adults, worry about

physical and psychological effects of marijuana use is the most often cited factor for wanting to quit [79, 116]. For example, Copersinio et al. [30] reported that 60% of non-treatment-seeking adult weekly marijuana users reported worry about health problems (both real and perceived) as a motivating factor for quitting, and 63% desired to quit in order to gain more “self-control” over their lives. In another study, Reilly and colleagues [89] similarly found that anxiety or depressive symptoms were the most commonly reported “negative effects” of marijuana use and the primary reason for quitting among weekly marijuana users ($n = 268$). Others have reported similar findings among both non-treatment seekers [12] and treatment seekers [103]; such findings do not appear to vary as a function of the type of marijuana use problem [12]. Overall, these data suggest that marijuana users typically express multiple reasons for quitting, with the most common reasons pertaining to excessive negative emotional symptoms (e.g., anxiety and depression, worry about negative health effects of marijuana use) and impaired levels of personal self-control associated with regular marijuana use.

Success in Quitting

Individuals attempting to quit marijuana experience marked difficulty whether they make a quit attempt on their own or seek professional (formal) treatment. Numerous survey studies, for example, have documented that current, regular marijuana users (both those who are and are not dependent on the drug) who try to quit on their own report difficulty in remaining abstinent, as indexed by numerous unsuccessful quit attempts [30, 116].

Although self-quit attempts (without professional assistance) tend to be the most frequently employed quit strategy [12], it is striking that even among those who *do* seek professional treatment, relapse to use is a common experience. Indeed, in a critical review of the

treatment outcome literature for marijuana dependence, McRae and colleagues [82] concluded: “studies suggest that many patients do not show a positive treatment response, indicating that marijuana dependence is not easily treated” (p. 369). For example, one large-scale controlled study ($n = 291$) found that 63% of adults receiving two of the best available intervention strategies—motivational individualized intervention or cognitive-behavioral therapy—relapsed to regular use within 4 months [102]. For comparison purposes, the delayed treatment (control) condition reported that 91% of individuals were not abstinent at the 4-month assessment [102]. At 16 months, relapse rates among the active treatment conditions rose to 71 and 72% for the motivational individualized intervention and cognitive-behavioral therapy, respectively [102]. Other studies have reported similar results [29, 100, 104], and more recent clinical trials have extended such work by noting that in addition to full relapse, lapses are highly common and clinically significant. For example, Moore and Budney [84] reported that among marijuana-dependent adult outpatients receiving treatment ($n = 152$), 71% lapsed (defined as any marijuana use) within 6 months, 46% within 3 months, and 24% within 1 month. In the same study, 71% of lapsers ultimately experienced a full relapse (defined as 4 or more days of use per week) [84].

It also should be noted that there have been historically few pharmacotherapy options available for marijuana use disorders. In fact, currently there are no medications approved by the United States Food and Drug Administration for marijuana use disorders, although a number of agents are currently being investigated. See Chapter “Potential Pharmacotherapies for Cannabis Dependence” for further details.

Although marijuana relapse is now a well-documented, prevalent clinical problem, there has been relatively little scientific work focused on predictors of success or failure in attempts to quit using marijuana. The work that has been completed in this regard has been broadly guided by social learning [7], stress and coping [70], and

behavioral economic [8] theories of substance use and relapse. These studies have thus far provided a number of initial and important observations: (1) early lapses are predictive of later relapses among adult and adolescent marijuana-abusing or -dependent persons, regardless of whether they receive formal treatment or not [1, 54, 73, 84]; (2) personal stressors (e.g., family conflict) are related to relapse among individuals with marijuana abuse or dependence receiving outpatient treatment [44]; (3) other substance use and peers’ substance use (alcohol and other drugs) are predictive of relapse to marijuana use among adolescent marijuana-abusing or -dependent outpatients [73], and (4) the level of self-efficacy (i.e., beliefs regarding one’s ability to refrain from use) for abstaining from marijuana use among adults with marijuana abuse or dependence seeking treatment is predictive, albeit modestly in terms of effect size, of later relapse [76, 105].

Marijuana: Overview of Clinical Issues Relevant to Practitioners

Given that marijuana use and its disorders are common and can be associated with a relatively wide variety of negative problems, clinicians such as primary care physicians who interact with patients in non-specialty clinical settings ought to be knowledgeable of basic issues in clinical care for this drug problem. To facilitate this process, we now turn to a discussion of some core clinical competencies by highlighting basic assessment and treatment strategies. This discussion is broadly relevant to clinical practitioners working in medical, dental, and psychological sectors of the health care industry. The topics discussed in this domain are not intended to be exhaustive or indicative of the full range of possible clinically relevant issues. They are, however, intended to offer some initial insight into the basic skills and knowledge that may be required to interact effectively with the marijuana-using population.

Basic Competencies

The most basic level of competency of clinical relevance focuses on simply being aware of the scientifically developed knowledge on the prevalence and impact of marijuana and its disorders. Here, clinicians should initially strive to attain an overall awareness of marijuana use and behavior as it relates to their patient population(s). Specifically, it is important for clinicians to recognize that marijuana use is integrally related to a wide range of negative life problems (e.g., respiratory illness). By obtaining such knowledge of marijuana use and its disorders, the clinician is better equipped to offer patients accurate information about problems related to marijuana use. This information can include psychoeducational “facts” (e.g., how marijuana may impact lung disease), but also may involve strategies designated (through scientific evaluation) as helpful to quitting, such as brief motivational interventions [103]. To gain access to this information, practicing clinicians can consider both informal and formal methods of education. More specific goal-oriented targets can include, but are not limited to, being able, efficiently and capably, to: (1) describe the prevalence of marijuana use and its disorders, (2) describe regional marijuana use patterns, (3) describe the negative physical and psychological consequences of marijuana use and dependence, (4) describe the importance and role of marijuana treatment, particularly those methods based on evidence-based resources, (5) maintain a general awareness of emerging research related to the treatment of marijuana use and its disorders, (6) understand the criteria used for defining marijuana use, abuse, and dependence, and (7) communicate an interest and willingness to consult with other resources when marijuana knowledge may be limited.

A second basic competency skill domain pertains to developing basic assessment and counseling skills for dealing effectively with marijuana use and its disorders. This domain of competence naturally builds from the foregoing description of general knowledge and

awareness. This area of work necessarily begins with developing a level of “clinical comfort” with marijuana use topics and being capable of engaging a patient in a discussion focused on this topic. For this reason, the basic competency element in this domain requires counseling skills that strengthen interpersonal connection (e.g., rapport, listening to patient concerns). From the counseling perspective, a variety of core skills are necessary. These include, but are not limited to: (1) having the capacity to be an active listener and demonstrate an empathetic stance regarding clinical care involving marijuana-related issues, (2) being able to communicate the strengths and challenges to evidence-based care treatment approaches for marijuana use and its disorders in a non-threatening manner, and (3) being able to understand basic models of behavior change that pertain to marijuana use and meaningfully communicate levels of “motivational stage and readiness” to clients.

From an assessment perspective, basic competencies are needed in order to understand how to evaluate marijuana use behavior and history adequately. Without this level of proficiency, it will be challenging to document readiness to quit or success in doing so. In the assessment process, there are both historical and current factors to evaluate. The overarching goal is to learn to comprehensively document and obtain accurate information that can be used in a clinically meaningful manner. The assessment process can be usefully divided into two global phases: intake (or initial assessment) and ongoing assessment. For the intake assessment, key variables to assess include: the extent and nature of marijuana use from a lifetime and current perspective; documenting current interest and motivation in quitting; employing evidence-based technologies for documenting marijuana use, abuse, and dependence; identifying (with the client) barriers to quitting currently; identifying strengths in the client or the environment (e.g., social support) for quitting; documenting the nature of past quit history and relative degree of success in such attempts, and personal as well as cultural variables that may impact marijuana use and decisions regarding use. The

intake assessment process should also integrate information about the client's medical and psychological history (e.g., concurrent substance use) in order to understand how such factors may influence the ongoing marijuana use or attempts to quit.

Ongoing assessments require an understanding of each client and the specific variables that need to be regularly tracked in order to accurately and objectively document (and understand) the motivation to quit and marijuana use behavior. Here, there will be differences across individuals, but in most instances marijuana use behavior, ongoing life stressors, and current motivation to quit are possibly important targets. This information can be used to track and understand ongoing efforts to quit. For example, clinicians should take note of each client's specific thoughts related to marijuana use (e.g., belief that marijuana use functions as an effective method of stress management), primary reason(s) for wanting to quit smoking (e.g., health, social stigma), and situations in which marijuana use is most likely to occur (e.g., when drinking alcohol). This information, in turn, can be applied to help educate clients about their specific marijuana use patterns and, ultimately, help them formulate a plan for making a quit attempt that is individualized to their specific needs and life circumstances.

Aside from the individual level of commitment to professional development, it is a reality that most medical care occurs within a context that intersects with other health care professionals. Therefore, enlisting in an integrated manner the systems involved in such clinical work may be a powerful resource for dealing with marijuana use and its disorders. The need for such systems-oriented care is particularly evident given that educational efforts solely focused on the individual have not always been met with large degrees of success in the substance use field (e.g., [114]). Additionally, many individuals seek medical care in medical systems governed by managed care businesses or other third party payers. As a result, changes to a system of medical care can have a major impact in terms

of the type and quality of care administered by practitioners working within that system.

Summary

Understanding and treating marijuana use is an important public health priority. Despite the increasing recognition that marijuana use and its disorders are not actually "harmless", the scientific literature pertaining to the etiology and maintenance, assessment, and treatment of marijuana use and its disorders is still in its beginnings. The next decade promises to be an important time to marshal resources in order to bridge major knowledge gaps and translate such developments into promising prevention and treatment approaches.

References

1. Agosti V, Levin F (2007) Predictors of cannabis dependence recovery among epidemiological survey respondents in the United States. *Am J Drug Alcohol Abuse*, 33:81–88
2. American Psychiatric Association (2000) *Diagnostic and statistical manual of mental disorders*, 4th edn, text revision. American Psychiatric Association, Washington, DC
3. Anthony JC, Helzer JE (1991) Syndromes of drug abuse and dependence. In: *Psychiatric disorders in America: the epidemiologic catchment area study*. Free, New York
4. Anthony JC, Warner LA, Kessler RC (1994) Comparative epidemiology of dependence on tobacco, alcohol, controlled substances, and inhalants: basic findings from the national comorbidity survey. *Exp Clin Psychopharmacol* 2:244–268
5. Ashton CH (1999) Adverse effects of cannabis and cannabinoids. *Br J Anaesthesia* 83:637–649
6. Ashton CH (2001) Pharmacology and effects of cannabis: a brief review. *Br J Psychiatry* 178: 101–106
7. Bandura A (2000) Social-cognitive theory. *Encyclopedia of psychology*, vol 7. American Psychological Association, Washington, DC, New York, pp 329–332
8. Bickel WK, Vuchinich RE (2000) Reframing health behavior change with behavioral economics. Lawrence Erlbaum, Mahwah, NJ

9. Bloom JW, Kaltenborn WT, Paoletti P, Camilli A, Lebowitz MD (1987) Respiratory effects of non-tobacco cigarettes. *Br Med J* 295:1516–1518
10. Bonn-Miller MO, Zvolensky MJ, Bernstein A (2007) Marijuana use motives: concurrent relations to frequency of past 30-day use and anxiety sensitivity among young adult marijuana smokers. *Addict Behav* 32:49–62
11. Bowers M, Boutros N, D'Souza DC, Madonick S (2001) Substance abuse as a risk factor for schizophrenia and related disorders. *Int J Mental Health* 30:33–57
12. Boyd S, Tashkin D, Huestis M, Heishman S, Dermand J, Simmons M, et al (2005) Strategies for quitting among non-treatment-seeking marijuana smokers. *Am J Addict* 14:35–42
13. Brook JS, Rosen Z, Brook DW (2001) The effect of early marijuana use on later anxiety and depressive symptoms. *NYS Psychol* January:35–39
14. Budney AJ, Higgins ST, Radonovich KJ, Novy PL (2000) Adding voucher-based incentives to coping skills and motivational enhancement improves outcomes during treatment for marijuana dependence. *J Consulting Clin Psychol* 68:1051–1061
15. Budney AJ, Hughes JR, Moore BA, Novy PL (2001) Marijuana abstinence effects in marijuana smokers maintained in their home environment. *Archiv Gen Psychiatry* 58:917–924
16. Budney AJ, Hughes JR, Moore BA, Vandrey R (2004) Review of the validity and significance of cannabis withdrawal syndrome. *Am J Psychiatry* 161:1967–1977
17. Budney AJ, Hughes JR, Moore BA, Vandrey R (2004) Review of the validity of the significance of cannabis withdrawal syndrome. *Am J Psychiatry* 161:1967–1977
18. Budney AJ, Moore BA, Vandrey R, Hughes JR (2003) The time course and significance of cannabis withdrawal. *J Abnormal Psychol* 112(3):393–402
19. Budney AJ, Novy PL, Hughes JR (1999) Marijuana withdrawal among adults seeking treatment for marijuana dependence. *Addiction* 94:1311–1322
20. Caplan GA, Brigham BA (1989) Marijuana smoking and carcinoma of the tongue. Is there an association? *Cancer* 66:1005–1006
21. Chait LD, Zacny JP (1992) Reinforcing and subjective effects of oral Δ^9 -THC and smoked marijuana in humans. *Psychopharmacology* 107:255–262
22. Charbrol H, Duconge E, Casas C, Roura C, Carey KB (2005) Relations between cannabis use and dependence, motives for cannabis use and anxious, depressive and borderline symptomatology. *Addict Behav* 30:829–840
23. Chen C-Y, Wagner FA, Anthony JC (2002) Marijuana use and the risk of major depressive episode: epidemiological evidence from the United States national comorbidity survey. *Soc Psychiatry Psychiatric Epidemiol* 37:199–206
24. Chen K, Kandel DB, Davies M (1997) Relationships between frequency and quantity of marijuana use and last year proxy dependence among adolescents and adults in the United States. *Drug Alcohol Depend* 46:53–67
25. Coates RA, Farewell VT, Raboud J, Read SE, MacFadden DK, Calzavara LM, Johnson JK, Shepherd FA, Fanning MM (1990) Cofactors of progression to acquired immunodeficiency syndrome in a cohort of male sexual contacts of men with human immunodeficiency virus disease. *Am J Epidemiol* 132:717–722
26. Compton WM, Grant BF, Colliver JD, Glantz MD, Stinson FS (2004) Prevalence of marijuana use disorders in the United States: 1991–1992 and 2001–2002. *J Am Med Assoc* 291:2114–2121
27. Cooper ML (1994) Motivations for alcohol use among adolescents: development and validation of a four-factor model. *Psychol Assess* 6:117–128
28. Cooper M, Frone M, Russell M, Mudar P (1995) Drinking to regulate positive and negative emotions: a motivational model of alcohol use. *J Pers Soc Psychol* 69:990–1005
29. Copeland J, Swift W, Roffman R, Stephens R (2001) A randomized controlled trial of brief cognitive-behavioural interventions for cannabis use disorder. *J Subst Abuse Treat* 21:55–64
30. Copersino M, Boyd S, Tashkin D, Huestis M, Heishman S, Dermand J, et al (2006) Quitting among non-treatment-seeking marijuana users: reasons and changes in other substance use. *Am J Addict* 15:297–302
31. Cox W, Klinger E (1988) A motivational model of alcohol use. *J Abnorm Psychol* 97:168–180
32. Cunningham J (2000) Remissions from drug dependence: is treatment a prerequisite? *Drug Alcohol Depend* 59:211–213
33. Day NL, Wagener DK, Taylor PM (1985) Measurement of substance use during pregnancy: methodologic issues. *NIDA Res Monogr* 59:36–47
34. Degenhardt L, Hall W, Lynskey M (2001) Alcohol, cannabis, and tobacco use among Australians: a comparison of their associations with other drug use and disorders, affective and anxiety disorders, and psychosis. *Addiction* 96:1603–1614
35. Dennis M, Babor TF, Roebuck MC, Donaldson J (2002) Changing the focus: the case for recognizing and treating cannabis use disorders. *Addiction* 97:4–15
36. Devane WA, Hanus L, Breuer A, Pertwee RG, Stevenson LA, Griffing G, Gibson D, Mandelbaum A, Etinger A, Mechoulam R (1992) Isolation and structure of a brain constituent that binds to the cannabinoid receptor. *Science* 258:1946–1949
37. Diamond G, Panichelli-Mindel SM, Shera D, Dennis M, Tims F, Ungemack J (2006) Psychiatric syndromes in adolescents with marijuana abuse

- and dependency in outpatient treatment. *J Child Adolesc Subst Abuse* 15:37–54
38. Didcott P, Flaherty B, Muir C (1988) A profile of addicts in residential treatment in New South Wales. Directorate of the Drug Offensive, in House Report Series. New South Wales Department of Health, Sydney
 39. D'Souza D, Abi-Saab S, Madonick K, Forselius-Bielen A, Doersch G, Braley R, Gueorguieva T, Cooper J, Krystal J (2000) Delta-9-tetrahydrocannabinol effects in schizophrenia: implications for cognition, psychosis, and addiction. *Biol Psychiatry* 57:594–608
 40. Everest JT, Tunbridge RJ, Widdop B (1989) The incidence of drugs in road accident fatalities. Department of Transport and Road Research Laboratory Research Report 202. Department of Transport Publications, London
 41. Fligiel SE, Roth MD, Kleerup EC, Barsky SH, Simmons MS, Tashkin DP (1997) Tracheobronchial histopathology in habitual smokers of cocaine, marijuana, and/or tobacco. *Chest* 112:319–326
 42. Gerstein DR, Johnson RA (2000) Nonresponse and selection bias in treatment follow-up studies. *Subst Use Misuse* 35:971–1014
 43. Gjerde H, Kinn G (1991) Impairment in drivers due to cannabis. *Forensic Sci Int* 50:57–60
 44. Godley M, Kahn J, Dennis M, Godley S, Funk R (2005) The stability and impact of environmental factors on substance use and problems after adolescent outpatient treatment for cannabis abuse or dependence. *Psychol Addict Behav* 19:62–70
 45. Goodstadt M, Sheppard M, Chan G (1984) Non-use and cessation of cannabis use: neglected foci of drug education. *Addict Behav* 9:21–31
 46. Green BE, Ritter C (2000) Marijuana use and depression. *J Health Soc Behav* 41:40–49
 47. Green B, Young R, Kavanagh D (2005) Cannabis use and misuse prevalence among people with psychosis. *Br J Psychiatry* 187:306–313
 48. Hall W, Degenhardt L (2004) Is there a specific 'cannabis psychosis'? In: *Marijuana and madness: psychiatry and neurobiology*. Cambridge University Press, New York
 49. Hall W, Johnston L, Donnelly N (1999) The epidemiology of cannabis use and its consequences. In: *The health effects of cannabis*. Centre for Addiction and Mental Health, Canada
 50. Hall W, Solowij N (1998) Adverse effects of cannabis. *Lancet* 352:1611–1616
 51. Hall W, Solowij N, Lemon J (1994) The health and psychological consequences of cannabis use. *National Drug Strategy Monograph Series*, 25, <http://www.druglibrary.org/schaffer/hemp/medical/HOME.HTM>
 52. Hambrecht M, Hafner H (2000) Cannabis, vulnerability, and the onset of schizophrenia: an epidemiological perspective. *Aust N Z J Psychiatry* 34:468–475
 53. Haney M, Ward AS, Comer SD, Foltin RW, Fischman MW (1999) Abstinence symptoms following smoked marijuana in humans. *Psychopharmacology* 141:395–404
 54. Harrison P, Asche S (2001) Adolescent treatment for substance use disorders: outcomes and outcome predictors. *J Child Adolesc Subst Abuse* 11:1–18
 55. Hathaway AD (2003) Cannabis effects and dependency concerns in long-term frequent users: a missing piece of the public health puzzle. *Addict Res Theory* 11:441–458
 56. Herkenham M, Lynn A, Little MD, Johnson MR, Melvin LS, de Costa BR, Rice KC (1990) Cannabinoid receptor localization in the brain. *Proc Natl Acad Sci USA* 87:1932–1936
 57. Hollister LE (1986) Health aspects of cannabis. *Pharmacol Rev* 38:1–20
 58. Hollister LE (1992) Marijuana and immunity. *J Psychoactive Drugs* 24:159–164
 59. Hubbard R, Collins J, Rachal J, Cavanaugh E (1988) The criminal justice client in drug abuse treatment. Compulsory treatment of drug abuse: research and clinical practice. National Institute on Drug Abuse, Rockville, MD, pp 57–80
 60. Hughes J (1996) The future of smoking cessation therapy in the United States. *Addiction* 91:1797–1802
 61. Hunt CA, Jones RT, Herning RI, Bachman J (1981) Evidence that cannabidiol does not significantly alter the pharmacokinetics of tetrahydrocannabinol in man. *J Pharmacokinetics Biopharmaceutics* 9:245–60
 62. Ikard FF, Green DE, Horn D (1969) A scale to differentiate between types of smoking as related to the management of affect. *Int J Addictions* 4:649–659
 63. Johns A (2001) Psychiatric effects of cannabis. *Br J Psychiatry* 178:116–122
 64. Johnston LD, O'Malley PM, Bachman JG (1995) National survey results on drug use from the monitoring the future study, 1975–1994. National Institute on Drug Abuse, Rockville, MD
 65. Johnston LD, O'Malley PM, Bachman JG (2003) Monitoring the future: national survey results on drug use, 1975–2002. National Institute of Drug Abuse, Bethesda, MD
 66. Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE (2004) Monitoring the future: national survey results on drug use, 1975–2003. University of Michigan, Institute for Social Research
 67. Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE (2005) Monitoring the future: national results on adolescent drug use. National Institutes of Health. US Department of Health and Human Services, Bethesda, MD
 68. Kalant H, Corrigan W, Hall W, Smart R (1999) The health effects of cannabis. Centre for Addiction and Mental Health, Canada

69. Kandel D, Chen K, Warner LA, Kessler RC, Grant B (1997) Prevalence and demographic correlates of symptoms of last year dependence on alcohol, nicotine, marijuana, and cocaine in the U.S. population. *Drug Alcohol Depend* 44:11–29
70. Kaplan HB (1996) Perspectives on psychosocial stress. In: *Psychosocial stress: perspectives on structure, theory, life-course, and methods*. Academic, San Diego, CA
71. Kaslow RA, Blackwelder WC, Ostrow DG, Yerg D, Palenick J, Coulson AH, Valdiserri RO (1989) No evidence for a role of alcohol or other psychoactive drugs in accelerating immunodeficiency in HIV-1-positive individuals: a report from the Multicenter AIDS Cohort Study. *J Am Med Assoc* 261:3424–3429
72. Katerndahl D, Realini J (1993) Lifetime prevalence of panic states. *Am J Psychiatry* 150:246–249
73. Latimer W, Winters K, Stinchfield R, Traver R (2000) Demographic, individual, and interpersonal predictors of adolescent alcohol and marijuana use following treatment. *Psychol Addict Behav* 14:162–173
74. Lehman WEK, Simpson DD (1992) Employee substance use and on-the-job behaviors. *J Appl Psychol* 77:309–321
75. Leirer VO, Yesavage JA, Morrow DG (1991) Marijuana carry-over effects on aircraft pilot performance. *Aviation Space Environ Med* 62: 221–227
76. Litt MD, Kadden RM, Stephens RS (2005) Coping and self-efficacy in marijuana treatment: results from the marijuana treatment project. *J Consult Clin Psychol* 73:1015–1025
77. Loeber RT, Yurgelun-Todd DA (1999) Human neuroimaging of acute and chronic marijuana use: implications for frontocerebellar dysfunction. *Human Psychopharmacol Clin Exp* 14:291–304
78. Lynskey M, Hall W (2000) The effects of adolescent cannabis use on educational attainment: a review. *Addiction* 95:1621–1630
79. Martin CE, Duncan DF, Zunich EM (1983) Students' motives for discontinuing illicit drug-taking. *Health Values* 7:8–11
80. Mathers DC, Ghodse AH (1992) Cannabis and psychotic illness. *Br J Psychiatry* 161:648–653
81. McDonald J, Schleifer L, Richards JB, de Wit H (2003) Effects of delta⁹-tetrahydrocannabinol on behavioral measures of impulsivity in humans. *Neuropsychopharmacology* 28:1356–1365
82. McRae AL, Budney AJ, Brady KT (2003) Treatment of marijuana dependence: a review of the literature. *J Subst Abuse Treat* 24:369–376
83. Mitchell H, Zvolensky MJ, Marshall EC, Bonn-Miller MO, Vujanovic AA (2007) Incremental validity of coping-oriented marijuana use motives in the prediction of affect-based psychological vulnerability. *J Psychopathol Behav Assess* 29: 277–288
84. Moore B, Budney A (2003) Relapse in outpatient treatment for marijuana dependence. *J Subst Abuse Treat* 25:85–89
85. Newcombe MD, Bentler P (1988) Consequences of adolescent drug use: impact on the lives of young adults. Sage, Newbury Park, CA
86. O'Dea PJ, Murphy B, Balzer C (1997) Traffic and illegal production of drugs in rural America. In: Robertson EB, Sloboda Z, Boyd GM, Beatty L, Kozel NJ (eds) *Rural substance abuse: state of knowledge and issues*. NIDA Res Monogr 168: 79–89
87. Ohlsson A, Lindgren JE, Wahlen A, Agurell S, Hollister LE, Gillespie HK (1980) Plasma delta-9 tetrahydrocannabinol concentrations and clinical effects after oral and intravenous administration and smoking. *Clin Pharmacol Therapeutics* 28:409–416
88. Piper ME, Piasecki TM, Federman EB, Bolt DM, Smith SS, Fiore MC, Baker TB (2004) A multiple motives approach to tobacco dependence: the Wisconsin inventory of smoking dependence motives (WISDM-68). *J Consult Clin Psychol* 72:139–154
89. Reilly D, Didcott R, Swift W, Hall W (1998) Long-term cannabis use: characteristics of users in an Australian rural area. *Addiction* 93:837–846
90. Russell MAH, Peto J, Patel UA (1974) The classification of smoking by factorial structure of motives. *J Royal Stat Soc* 137:313–329
91. Schuckit MA (1989) Drug and alcohol abuse: a clinical guide to diagnosis and treatment, 3rd edn. In: *Critical issues in psychiatry: an educational series for residents and clinicians*. Plenum Medical Book Co/Plenum, New York, NY, England
92. Sells SB (1974) The effectiveness of drug abuse treatment: I & II. Ballinger, Oxford, England
93. Semple DM, McIntosh AM, Lawrie SM (2005) Cannabis as a risk factor for psychosis: systematic review. *J Psychopharmacol* 19:187–194
94. Sherrill DL, Krzyzanowski M, Bloom JW, Lebowitz MD (1991) Respiratory effects of non-tobacco cigarettes: a longitudinal study in general population. *Int J Epidemiol* 20:132–137
95. Simpson DD, Savage LJ, Lloyd MR, Sells SB (1978) Evaluation of drug abuse treatments based on first year follow-up (NIDA Services Research Monograph Series, DHEW No. ADM 78–701). U.S. Government Printing Office, Washington, DC
96. Simons J, Correia CJ, Carey KB (2000) A comparison of motives for marijuana and alcohol use among experienced users. *Addict Behav* 25: 153–160
97. Simons J, Correia CJ, Carey KB, Borsari BE (1998) Validating a five-factor marijuana motives measure: relations with use, problems, and alcohol motives. *J Counseling Psychol* 3:265–273
98. Solowij N (1998) Cannabis and cognitive functioning. University Press, Cambridge

99. Sridhar KS, Raub WA, Weatherby NL Jr, Metsch LR, Surratt HL, Inciardi JA, Duncan RC, Anwyl RS, McCoy CB (1994) Possible role of marijuana smoking as a carcinogen in the development of lung cancer at a young age. *J Psychoactive Drugs* 26:285–288
100. Stephens RS (1999) Effects of brief and extended treatment on marijuana use and related problems. In: Babor T (Chair) *Treatment of marijuana dependence*. Symposium conducted at the meeting of the American Public Health Association, Chicago
101. Stephens RS, Babor TF, Kadden R, Miller M, the Marijuana Treatment Project Group. (2002) The marijuana treatment project: rationale, design, and participant characteristics. *Addiction* 97:109–124
102. Stephens RS, Roffman RA, Curtin L (2000) Comparison of extended versus brief treatments for marijuana use. *J Consult Clin Psychol* 68:898–908
103. Stephens RS, Roffman RA, Simpson EE (1993) Adult marijuana users seeking treatment. *J Consult Clin Psychol* 61:1100–1104
104. Stephens RS, Roffman RA, Simpson EE (1994) Treating adult marijuana dependence: a test of the relapse prevention model. *J Consult Clin Psychol* 62:92–99
105. Stephens R, Wertz J, Roffman R (1995) Self-efficacy and marijuana cessation: a construct validity analysis. *J Consult Clin Psychol* 63:1022–1031
106. Stewart SH, Zeitlin SB, Samoluk SB (1996) Examination of a three-dimensional drinking motives questionnaire in a young adult university student sample. *Behav Res Therapy* 34:61–71
107. Stewart SH, Zvolensky MJ, Eifert GH (2001) Negative-reinforcement drinking motives mediate the relation between anxiety sensitivity and increased drinking behavior. *Pers Individual Differences* 31:157–171
108. Substance Abuse and Mental Health Services Administration (1998) *Services research outcome study*. Department of Health and Human Services Publication No. SMA 98–3177. Author, Rockville, MD
109. Sussman S, Stacy A, Dent C, Simon T (1996) Marijuana use: current issues and new research directions. *J Drug Issues* 26:695–733
110. Tanda G, Goldberg SR (2003) Cannabinoids: reward, dependence, and underlying neurochemical mechanisms – a review of recent preclinical data. *Psychopharmacology* 169:115–134
111. Tashkin DP (1993) Is frequent marijuana smoking harmful to health? *Western J Med* 158:635–637
112. Tashkin DP, Simmons MS, Sherrill DL, Coulson AH (1997) Heavy habitual marijuana smoking does not cause an accelerated decline in FEV1 with age. *Am J Respir Critical Care Med* 155:141–148
113. Thomas H (1996) A community survey of adverse effects of cannabis use. *Drug Alcohol Depend* 42:201–207
114. Thorndike AN, Rigotti NA, Stafford RS, Singer DE (1998) National patterns in the treatment of smokers by physicians. *JAMA: J Am Med Assoc* 279:604–608
115. Tunving K (1985) Psychiatric effects of cannabis use. *Acta Psychiatrica Scandinavica* 72:209–217
116. Weiner M, Sussman S, McCuller W, Lichtman K (1999) Factors in marijuana cessation among high-risk youth. *J Drug Education* 29:337–357
117. Young ME, Rintala DH, Rossi CD, Hart KA, Fuhrer MJ (1995) Alcohol and marijuana use in a community-based sample of persons with spinal cord injury. *Archiv Phys Med Rehab* 76:525–532
118. Zvolensky M, Bernstein A, Sachs-Ericsson N, Schmidt N, Buckner J, Bonn-Miller MO (2006) Lifetime associations between cannabis, use, abuse, and dependence and panic attacks in a representative sample. *J Psychiatr Res* 40(6):477–486
119. Zvolensky MJ, Bonn-Miller MO, Bernstein A, McLeish AC, Feldner MT, Leen-Feldner EW (2006) Anxiety sensitivity interacts with marijuana use in the prediction of anxiety symptoms and panic-related catastrophic thinking among daily tobacco users. *Behav Res Ther* 44:907–924
120. Zvolensky MJ, Feldner MT, Leen-Feldner E, Bonn-Miller MO, McLeish AC, Gregor K (2004) Evaluating the role of anxiety sensitivity in smoking outcome expectancies among regular smokers. *Cogn Ther Res* 28:473–486
121. Zvolensky MJ, Lewinsohn P, Bernstein A, Schmidt NB, Buckner JD, Seeley J, Bonn-Miller MO (2008) Prospective associations between cannabis use, abuse, and dependence and panic attacks and disorder. *J Psychiatr Res* 42:1017–1023
122. Zvolensky MJ, Vujanovic AA, Bernstein A, Bonn-Miller MO, Marshall EC, Leyro T (2007) Marijuana use motives: a confirmatory test and evaluation among young adult marijuana users. *Addict Behav* 32:3122–3130