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Individual and Contextual Predictors of Severity of Marijuana Use Events among Young Frequent Users

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Abstract

This study used momentary sampling to characterize marijuana events among young frequent users and determine contextual and individual predictors of use severity. Medical clinic outpatients aged 15–24 who used marijuana at least twice a week completed a baseline assessment, then used a handheld computer to report marijuana use at 4–6 signal-prompted times per day and before/after use for two weeks. Reports assessed event characteristics (when, with whom, where, how, why, how much, how high). Timestamps identified time, weekend, and duration for each event. Generalized estimating equations tested associations of individual and event-specific contextual characteristics with hits/event, duration, and high. Forty-one youth completed 3868 momentary reports; 40 (98%) reported at least one marijuana use event ($N=432$ events; $M=10.5$ /participant) and thus provided data for these analyses. Marijuana was most commonly used with other people (74% of events), at home (58%), via blunt (66%), and for social or enhancement reasons (86%). Most events (62%) occurred on weekdays; use was least likely in the morning (8%). Most events involved 6 or more hits (81%). Mean high was 5.2 (out of 8). Of events with start and end times ($n=250$), mean duration was 46.8 minutes. Poor mental health and use with a blunt or a bong, in the morning or evening, and on the weekend were associated with 6 or more hits/event. Female gender was associated with greater event duration. Poor mental health predicted higher high. Among youth who used frequently, marijuana was used in a variety of contexts, with diversity in method, dose, and duration. Contextual factors appeared to predict marijuana dose for a given event, while individual characteristics were more predictive of high and duration.

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Contributors

Dr. Shrier was the PI of the study, designed the study, wrote the protocol, and supervised data collection and analysis. Ms. Walls managed the database and conducted the statistical analyses. Ms. Rhoads reviewed data quality and summarized the individual-level data. Dr. Blood advised on the analytic plan and interpretation of the results. Dr. Shrier wrote the manuscript and all authors contributed to and have approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

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Keywords

Marijuana use; adolescents; young adults; events; context

1. Introduction

Marijuana is the most frequently used illicit substance among adolescents and young adults (Substance Abuse and Mental Health Services Administration, 2011). In contrast to the decline in alcohol use, marijuana use among young people has been increasing in recent years (Johnston, O'Malley, Bachman, & Schulenberg, 2011). Of particular concern is the increase in frequent use, with approximately one in 15 high school seniors reporting daily or near daily marijuana use (Johnston et al., 2011). Marijuana use starting in adolescence is associated with increased risk of developing psychotic symptoms (Stefanis et al., 2004) and depression (Brook, Brook, Zhang, Cohen, & Whiteman, 2002), having lower educational and occupational expectations and performance, receiving public assistance, and other negative psychosocial outcomes such as engaging in criminal behavior (Ellickson, Martino, & Collins, 2004; Ellickson, Tucker, Klein, & Saner, 2004; Fergusson & Horwood, 1997). Research is needed to improve our understanding of marijuana use among those most at-risk, adolescents and young adults who are using frequently.

Heavy or severe use is typically defined by number of times ever or over a defined period of time (e.g., 40 or more times in lifetime (Miller & Plant, 2002); once a week or more (Barnes, Barnes, & Patton, 2005)). Regardless of the criterion used to define heavy use, within a group of "heavy users" there may be considerable heterogeneity in sociodemographic, personality, and familial characteristics of the individuals (Barnes et al., 2005; Miller & Plant, 2002). However, severity of use has not been extensively examined on the event level, that is, how much marijuana, for how long, and producing what degree of high per episode. Thus, little is known about how individual characteristics may predict event-level severity of use. Age and gender, for example, did not differentiate heavy from moderate use when defined by use frequency (Barnes et al., 2005), but other research found that male adolescents and young adults were more likely than their female counterparts to use, abuse, and be dependent on marijuana, with differences also noted between the adolescent and young adult age groups (Cotto et al., 2010). Examination of differences in the extent of use in specific use episodes may help to elucidate inconsistent findings in the literature.

The psychological state ("set"; Zinberg, 1986) of an individual may also influence marijuana use. Among younger (Wills, Vaccaro, & McNamara, 1992) and older adolescents (Hussong & Hicks, 2003), recent negative affect has been associated with greater use of substances, including marijuana. Incarcerated male adolescents with high levels of depression and anxiety were more likely than their peers with less negative mood to report using marijuana to regulate mood and to report more marijuana-related consequences (Turner, Larimer, Sarason, & Trupin, 2005). Although several studies have not found social anxiety to be related to greater marijuana use frequency (Buckner, Bonn-Miller, Zvolensky, & Schmidt, 2007; Buckner & Schmidt, 2008; Myers, Aarons, Tomlinson, & Stein, 2003), social anxiety has been associated with greater problems from marijuana use, i.e., dependence (Buckner et al., 2008). Positive affect has been linked to less use of marijuana and other substances, (Collins et al., 1998; Wills, DuHamel, & Vaccaro, 1995; Wills, Sandy, Shinar, & Yaeger, 1999) although not consistently so (Cooper, Frone, Russell, & Mudar, 1995).

There is also evidence to suggest that for a given individual, use may vary as a function of social context. Social context can influence not only how much drug is taken and for how

long, but also expectations for the experience that can contribute to how high someone feels after a use episode (Goode, 1999). Sentinel research on the “setting” of drug use found that marijuana, in particular, may be used in a wide variety of social situations (Zinberg, 1986). Severity of use may differ according to how and with whom the drug is taken, with blunt smoking in social groups being associated with moderation of use and level of intoxication (Dunlap, Johnson, Benoit, & Sifaneck, 2005).

Marijuana use is typically assessed by recall over days-to-months. Even with calendar recall of recent use over short time periods (Sobell, Sobell, Litten, & Allen, 1992), it may be difficult for frequently-using individuals to remember details about discrete use events (Indlekofer et al., 2009). Capturing data on marijuana use events in real or near-real time can minimize biases and omissions associated with recall (Shiffman et al., 1997). Momentary sampling methods (e.g., Ecological Momentary Assessment (Shiffman, 2000); Experience Sampling Method (Hektner, Schmidt, & Csikszentmihalyi, 2007)) use handheld computers to facilitate self-report of feelings, social context, and behaviors as they are occurring in the natural environment. Individuals can complete reports when prompted by signals, as well as when a behavior of interest occurs, thereby limiting the amount of time over which to recall details about the behavior as well as about the context in which it occurred. Momentary sampling studies of substance use have found contextual correlates of use, including being alone and at home (cocaine use vs. abstinence; Epstein & Preston, 2010) and being with a boyfriend or girlfriend (on drinking days; Kauer, Reid, Sanci, & Patton, 2009). However, very few recent studies have examined the social context surrounding marijuana use events in non-clinical populations (Larson, Csikszentmihalyi, & Freeman, 1984; Tournier, Sorbara, Gindre, Swendsen, & Verdoux, 2003). Further, most studies of marijuana use events have considered all episodes of use to be equal, without regard to how much marijuana was used, for how long, or how much high was experienced (Larson, et al., 1984; Tournier, et al., 2003). In some event studies, marijuana use has been assessed as it is about to happen (Buckner, Crosby, Silgado, Wonderlich, & Schmidt, 2012; Buckner et al., 2011), rendering impossible the collection of data on the degree of use.

In sum, the heterogeneity of use within as well as across individuals, and how severity of the use events may differ according to methods of drug administration and social context, has not been fully explored. The objectives of the present study were first to characterize marijuana use events among adolescents and young adults who use marijuana frequently. We then sought to determine individual and event-level contextual characteristics that predicted dose, duration, and highest level of high from a marijuana use event. While we anticipated differences in use severity according to individual and contextual factors, we did not assert hypotheses *a priori* given the limited previous research using event-level data.

2. Materials and Method

2.1. Participants

Data for the analyses herein came from participants of a momentary sampling study of affect, social context, and marijuana use (N = 44). Youth aged 15 to 24 years who were receiving primary care from one of two adolescent/young adult medical clinics were recruited into the study if they reported marijuana use at least twice a week, on average. The clinics are affiliated with a pediatric hospital in a large Northeastern city and collectively serve a racially, ethnically, and socioeconomically diverse population of more than 6,000 youth each year.¹ Clinic providers referred age-eligible patients who reported current marijuana use to the study coordinator. Patients could also refer themselves after reading a

¹The participants contributing data for the analyses herein (n=40) were 35% black, non-Hispanic, 35% Hispanic, 15% white, non-Hispanic, and 15% other or multi-race/ethnicity.

brochure available in the clinics that described the eligibility criteria and outlined the study procedures. To participate, youth needed to be willing to provide at least one piece of contact information, be able to communicate in English, not have any emotional or cognitive problems that would preclude understanding the informed consent process or other study procedures (as determined by the referring clinician), and not have concerns about safety related to study participation. Potential participants who had used marijuana in the previous three hours or those who had used marijuana in the previous six hours and reported being or appeared to be high were not enrolled. Details of the study protocol have been reported elsewhere (Shrier, Walls, Kendall, & Blood, in press). The hospital institutional review board affiliated with the recruitment sites approved the study with a waiver of parental consent for individuals under the age of 18 years (Department of Health and Human Services, National Institutes of Health, & Office for Protection from Research Risks, 2005; Santelli et al., 2003). For the current analyses, data were used from participants who provided momentary data and reported on at least one marijuana use event during the study ($n = 40$, 91%, one participant did not report any events, one returned without any data, and two were lost to follow up).

2.2 Procedures

Participants completed an audio computer-assisted self-interview (ACASI; QDS Software, Nova Research v. 2.1, Bethesda, MD) on sociodemographic characteristics, psychological traits and states, and substance use. They were then trained to use a handheld computer (Palm Tungsten E2) with a real-time data collection program (Configurable Electronic Real-Time Assessment System, CERTAS; PICS, Inc, Reston, VA). The computer was programmed to produce an auditory signal at random times within 3-hour intervals during each participant's self-identified waking hours, approximately 4–6 signals per day. In response, participants were asked to complete a report that included questions on recent marijuana use events. A discrete marijuana use event was defined as no break in use for longer than 30 minutes and no change in location during use (Black, de Moor, Kendall, & Shrier, in press). Participants responded to a mean of 71% of signals ($SD=21\%$). Participants were also asked to complete reports just before and just after using marijuana. Participants could make an "oops" report if they had completed a report indicating that they were about to use and then ended up not using or if they started to make a report of any type erroneously.

Based on our experience in the pilot study (Black, et al., in press), we asked participants to return to the clinic 2–4 days after beginning to make reports. A research assistant examined the data for errors related to when and how to make reports or to understanding the report questions and discussed remedies to the identified problems with the participant. Participants were asked to continue making reports for a minimum of 10 days after the check-in study visit. Thirty-three participants (83%) returned to have their data reviewed at a check-in visit. All participants collected data for at least 10 days, with 35 (85%) making reports on at least 14 days. At the conclusion of data collection, participants were asked to return for a follow-up assessment and remuneration (up to \$140 based on proportion of study activities completed, not on number of marijuana use reports).

2.3. Measures

2.3.1. Individual characteristics—Individual characteristics were assessed via ACASI. Participants reported their *age* (in years) and *sex*. Substance use history included *age at first marijuana use* (in years) and *current weekly frequency of use, on average* (number of times per week).

Positive and negative affect in the past two weeks was assessed with the Positive Affect-Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), which has been validated in adolescents (Huebner & Dew, 1995) as well as adults (Watson, et al., 1988). Participants indicated on a 5-point Likert-type scale the extent to which they felt each of 10 positive ($\alpha = .86$) and 10 negative ($\alpha = .78$) affective states (from 0, not at all, to 4, extremely).

Depressive symptoms during the past two weeks were assessed with the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), which consists of 21 groups of 4 statements each that measure the severity of depressive symptoms. Each item is scored from 0 to 3, and then the scores are summed, with higher total scores indicating more severe depressive symptoms (possible score, 0 to 63). The BDI-II has demonstrated excellent validity and test-retest and internal reliability in clinical samples, including in adolescents (Beck, et al., 1996). The Cronbach alpha in this sample was .89.

Social anxiety was assessed with the Social Anxiety Scale for Adolescents (SAS-A; La Greca, 1999), which was developed to measure “adolescents’ feeling of social anxiety in the context of their peer relations.” For each of 22 statements, participants indicated the extent to which they felt the statement was true for them (from 0, not at all, to 4, all the time). The SAS-A includes three subscales: fear of negative evaluation from peers, social avoidance and distress that is specific to new situations or unfamiliar peers, and social avoidance and distress that is experienced more generally when in the company of peers. Scores for the three subscales were summed to yield a total score, with higher scores indicating greater social anxiety. The SAS-A has been found to have good reliability and validity (Inderbitzen-Nolan & Walters, 2000; La Greca, 1999). The Cronbach alpha in the analytic sample was .91.

State and trait anxiety were measured with the State-Trait Anxiety Inventory (STAI; Spielberger, 1983). Respondents indicate the degree to which they feel each of 20 statements “right now” (from 0, not at all, to 3, very much so). The STAI has been widely used for both clinical and research purposes and normative data are available for high school students, college students, and adults (Spielberger, 1983). The Cronbach alpha in this sample was .74.

2.3.2. Contextual factors—For each marijuana use event, participants were asked to respond to questions about the social context and other use-related factors, including:

Companionship: Participants were asked whether they were alone and, if not, who was the main person they were with while they were using marijuana (boyfriend/girlfriend, other friends, parents, other family, other; the last three categories were combined for analysis).

Location: Participants were asked where they were during the use event (home, friend’s house, school, work, other; the last three categories were combined for analysis).

Vehicle of administration: Participants were asked to indicate the main way they used marijuana (joint, blunt, pipe, bong, ate it, vaporizer, other; the last three categories were combined for analysis).

Reason for use: Participants reported the main reason they used marijuana (to be more social, to cope, for pleasure to conform, to expand mind). Reasons were drawn from the Marijuana Motives Measure (Simons, Correia, & Carey, 1998), which assesses enhancement, conformity, expansion, coping, and social motives for marijuana use and has been shown to reliable and valid in youth. For the purposes of these analyses, reason for use

was categorized into enhancement, expansion, and social reasons versus conformity and coping reasons.

Date and time: Each report had an automatic date- and time-stamp. The report time was categorized into morning (6 am – 11:59 am), afternoon (12 pm – 5:59 pm), evening/night (6 pm – 11:59 pm), and late night/early morning (12 am – 5:59 am). The date and time were used to identify weekend, which was defined as Friday 3 pm to Sunday 11:59 pm (Larson & Richards, 1998; Shrier, Walls, Lops, Kendall, & Blood, 2012). For each marijuana use event, participants were asked to report the day (today, yesterday, some other day) and date that the marijuana use event occurred. On the signal-prompted reports and on reports made just after using marijuana, participants indicated the general time of day that they finished using marijuana (morning, afternoon, night), then the specific time to the nearest 15 minutes. On reports made just before using marijuana, the report date- and time-stamp was used to indicate the time that the episode of marijuana use began.

2.3.3. Severity of marijuana use events

Dose: For each marijuana use event completed, participants were asked how many hits they had. Response options were 1–5, 6–10, 11–15, 16–20 and 21 or more. In these analyses, dose was categorized into 1–5 hits versus 6 or more hits.

Highest high: Participants were also asked to indicate on a 9-point Likert-type scale how high was the highest they felt from the use of marijuana, with responses ranging from 0 (not at all high) to 8 (extremely high).

Duration: Reports made just before marijuana use were paired with a report made just after use or a report made in a response to a signal, whichever was completed closer in time to the time that the participant reported they had finished using marijuana. Duration of a marijuana use event (in minutes) was determined by subtracting the date- and time-stamp on a report made just before the use from the time that the participant reported finishing marijuana use.

2.3. Data Management and Analysis

A marijuana use event was considered to have occurred if a report of the use was made just after using or in response to a signal. Date and time of use were used to find reports corresponding to the same event. Reports of use that were followed by an “oops” report were excluded from analyses. The 40 participants who reported at least one marijuana use event completed 3812 reports ($M = 95.30/\text{participant}$, $SD = 40.53$, range=23–211), including 437 reports just before using, 357 reports just after using, and 364 signal-prompted reports of use. From these reports, 432 discrete marijuana use events were identified ($M = 10.8/\text{participant}$, $SD = 8.8$). Two hundred-fifty marijuana use events (58%) had both a start time and an end time and thus were included in the analyses involving event duration.

Descriptive statistics were calculated on the individual-level characteristics of the participants and on the event-level contextual factors and severity of use. Because the measures were highly correlated, we conducted a latent-class analysis on the individual-level psychological characteristics. One, two, and three class models were tested. Examination of the fit statistics (BIC, adjusted Lo-Mendell-Rubin likelihood ratio test and bootstrapped likelihood ratio test) showed that two classes best fit the data. The two classes were well separated with an entropy value of 0.995, indicating low likelihood of classification error. The two latent classes were identified as poorer mental health, which was characterized by lower positive affect, higher negative affect, more severe depressive symptoms, higher social anxiety, and higher state and trait anxiety, and better mental health, which was characterized by higher positive affect and lower negative mood symptoms. A

mental health class membership variable was then included as a covariate in subsequent regression models.

Associations of individual and event-specific contextual characteristics with each of the three event-level measures of severity of marijuana use (dose, highest high, and duration) were examined with linear and logistic regression models, as appropriate, using generalized estimating equations to adjust for within-individual clustering of events. First, bivariate analyses were conducted for each characteristic and each outcome. Then, all the individual and contextual characteristics were included in the multivariate model for each outcome and therefore the results reflect the independent association of each characteristic adjusting for all other characteristics. Results of comparisons among response categories other than the referent group were examined using model contrast statements. Associations were considered significant for $p < 0.05$. All analyses were conducted with SAS version 9.2 (SAS Institute, Cary, NC, 2002–2009).

3. Results

3.1. Descriptive statistics

3.1.1 Individual characteristics—The characteristics of the study participants are presented in Table 1. Mean age was 18.7 years (range, 15–24). A slight majority (58%) were female. Participants began using marijuana at a mean age of 13.7 (range, 6–19) and, at the time of enrollment, were using more than daily, on average. More than two-thirds of the sample reported symptoms of poorer mental health.

3.1.2. Event characteristics—The contextual characteristics and indicators of severity of use are presented in Table 1. Marijuana was most commonly used with a boyfriend/girlfriend or other friend (61%) and at home (58%) or at a friend's house (21%). Marijuana was usually administered via blunt (66%). Marijuana was used most commonly for enhancement, expansion, or social reasons (86%). Most events (62%) occurred on weekdays; use was least likely in the morning (8%). Most events involved at least 6 hits (86%). Mean high was 5.2 (out of 8). Of events with start and end times ($n=250$), mean duration was 46.8 minutes (median, 25.4 minutes).

3.2. Individual and contextual predictors of severity of marijuana use events

Results of the multivariate models examining individual and contextual predictors of event-specific severity of marijuana use (dose, highest high, and duration) are presented in Tables 2–4.

3.2.1. Dose—In the multivariate model (Table 2), youth with poorer mental health were more likely than those with better mental health to take 6 or more hits in a given marijuana use event (adjusted odds ratio [AOR] 3.77; 95% confidence interval [CI] 1.65, 8.64; $p=0.007$). Events were more likely to involve a dose of 6 or more hits when a blunt or bong was used, as compared to a pipe (AOR 5.25; 95% CI 2.28, 12.08; $p<0.001$ and AOR 5.81; 95% CI 1.86, 18.13; $p=0.003$, respectively). Model contrast statements showed that blunt and bong use were also more likely to involve a dose of 6 or more hits when compared to the other method category (AOR 2.96; 95% CI 1.20, 7.30; $p=0.02$ and AOR 3.27; 95% CI 0.95, 11.26; $p=0.06$, respectively; not shown in Table 2). Events were more likely to involve 6 or more hits if they occurred during the morning (6 am – 11:59 am) or the evening (6 pm – 11:59 pm), as compared to the late night/early morning (midnight – 5:59 am; AOR 3.23; 95% CI 1.27, 8.22; $p=0.014$ and AOR 2.65; 95% CI 1.40, 5.00; $p=0.003$, respectively). Model contrast statements showed that events during the morning and evening hours were also more likely to involve 6 or more hits if they occurred in the afternoon (noon – 5:59 pm;

AOR 2.64; 95% CI 1.03, 6.78; $p=0.044$ and AOR 2.16; 95% CI 1.28, 3.57; $p=0.004$, respectively; not shown in Table 2). Marijuana use on the weekend was more likely to involve 6 or more hits than use on weekdays (AOR 2.13; 95% CI 1.35, 3.38; $p=0.006$).

3.2.2. Highest high—In the adjusted model (Table 3), individuals with poorer mental health reported a higher high per marijuana use event than those with better mental health ($\beta=1.02$, $p=.001$). Younger participants tended to report a higher high from a given marijuana use event than older participants, but the association did not achieve significance ($\beta=-0.17$, $p=0.08$). Method of marijuana administration also trended toward a significant association with higher high ($p=0.07$); higher high was reported following marijuana use with a blunt, as compared to with a pipe ($\beta=0.78$, $p=0.007$).

3.2.3. Duration—Adjusted for other individual and event characteristics (Table 4), female participants used marijuana for an average of 24.3 minutes longer than male participants ($p=.04$). None of the other individual or contextual characteristics were associated with duration of a marijuana use event.

4. Discussion

In this study, we found heterogeneity in the contexts in which frequently-using youth used marijuana. Participants reported using both alone and with a variety of companion types; at home and friend's houses, as well as other settings; for many different types of reasons; and across times of the day and week. Consistent with other research (Golub, Johnson, & Dunlap, 2005), we found that youth who used marijuana frequently smoked blunts the majority of the time, but also used pipes, bong, and other methods of administration. Although all these young people could be classified as "heavy users," using marijuana at least twice a week to be in the study, there was substantial variation in how heavily they used in any given episode. We also observed considerable variability in individual-level characteristics of these heavily-using adolescents, consistent with previous research (Miller & Plant, 2002),

We identified several characteristics of both the person and of the use event that predicted how much, how high, and for how long. There has been some research to suggest that young people with depression and anxiety are more likely to use marijuana than their psychologically healthier peers (e.g., Saban, Flisher, & Distiller, 2010). Heavy marijuana use, in particular, has been associated with depression, although the direction of the association and possibility of confounding by social, familiar and/or contextual factors has not been elucidated (Degenhardt, Hall, & Lynskey, 2003). The results of our study suggest that youth with higher psychological distress may use more marijuana and achieve a higher high per a given episode of use, consistent with the concept that self-medication may motivate substance use in these individuals (Khantzian, 1997).

We also found that youth who use frequently were more likely to take at least 6 hits when they smoked blunts, as compared to pipes or other vehicles. This finding is in contrast to ethnographic research suggesting that blunt smoking is associated with more moderate use and level of intoxication (Dunlap et al., 2005). There was a trend toward blunt smoking being associated with longer duration of an episode of use; more time spent smoking may have contributed to the higher number of hits with blunt use. In addition, there is evidence that blunt smoking is associated with lesser increases in plasma levels of tetrahydrocannabinol (THC) compared to joint smoking (Cooper & Haney, 2009), so individuals may need more hits from a blunt than from a joint to achieve the desired high.

It was not surprising that the heavily-using youth in this study reported more hits on the weekend than on weekdays. Most youth were employed and/or in school and may have rules around their use that optimized their social functioning (Coggans, Dalgarno, Johnson, & Shewan, 2005; Johnson, Ream, Dunlap, & Sifaneck, 2008). However, it is interesting to note that participants were more likely to take 6 or more hits when using marijuana in the morning as well as the evening, compared to both the early morning hours and the afternoon. While studies in adolescents have found a correlation between participating in nighttime social events and regular (Peretti-Watel & Lorente, 2004) or heavy (Miller & Plant, 2002) use, research has not examined the degree of use within the social context of a given event among these more frequently-using youth. Young people may use marijuana in the morning to manage the social, academic, and occupational demands associated with school or work, consistent with many reasons for use cited in this and other studies, including to alter perspectives or perceptions, to enhance activities, to be more creative and original, to expand awareness, to relax, to be sociable, to fit in, and to feel more self-confident (Lee, Neighbors, & Woods, 2007; Simons, et al., 1998; Simons, Correia, & Carey, 2000; Zvolensky et al., 2007). Youth may use in the evening to relax or to aid with sleep (Bottorff, Johnson, Moffat, & Mulvogue, 2009). Only two participants in our sample reported recent use of cocaine or amphetamines, so we are unable to comment on whether higher doses of marijuana were being used in the evening to counter the effects of these drugs.

In this sample, young women used marijuana for a longer period of time per episode of use than their male counterparts. Although young men report current marijuana use at rates that are greater than those reported by young women, women have a greater biologic susceptibility to addiction as well as greater problems with adverse consequences from substance use than do men (Lynch, 2006; The National Center on Addiction and Substance Abuse at Columbia University, 2006). It will be important for future research to explore the contribution of the duration of marijuana use episodes to these sex differences in experiencing harm from use. There are also sex differences in the effectiveness of substance use interventions among youth, such that some interventions may be more effective in young women than in young men, and vice versa (Cotto et al, 2010; Flay, Graumlich, Segawa, Burns, & Holliday, 2004; Vicary et al., 2006). Our findings suggest that reducing the duration of use episodes may be an important target for interventions, especially among young women.

We also found a trend toward younger participants experiencing a higher high per marijuana use event than older participants, independent of age at first use and despite there being no difference in dose per event by age. Achieving a higher high may, in turn, motivate continued use, and thus may contribute to the development of marijuana dependence among individuals using heavily at a young age. We did not assess the potency of marijuana in this study. There is some indirect evidence that adolescents may be more inclined to use higher-potency marijuana than young adults. Specifically, differences in brain development and reward sensitivity may contribute to greater sensation-seeking among adolescents vs. adults (see Bava & Tapert, 2010 for a review). In addition, the potency of marijuana has been increasing (Mehmedic et al., 2010) and high-potency marijuana is embedded in areas of contemporary youth culture, such as rap music and popular media (Schensul et al., 2000). As a result, younger participants may have been exposed to higher-potency drug at a younger age compared to older participants. Future research with larger samples of adolescents and young adults is needed to discern the relative roles of brain development and marijuana potency in differences in level of intoxication across age.

The momentary sampling approach to data collection permitted us to offer multiple ways of reporting marijuana use events and minimize bias associated with recall, important for

maximizing the likelihood that participants reported the occurrence of, and details about, a marijuana use event. Nonetheless, this study is limited by its reliance on self-report. Participants were known to the researchers and thus may have under-reported the occurrence or severity of marijuana use events owing to socially desirable responding. Based on literature suggesting that youth may under-report substance use when at home (Gfroerer, Wright, & Kopstein, 1997) or with parents (Friedman, Johnson, & Brett, 1990), it is possible that under-reporting of event-related information could have occurred differentially across contexts for a given participant. Further, the sample size was small and drawn from two related clinics in a single city, limiting the generalizability of the findings.

In summary, we found substantial heterogeneity among adolescents and young adults who use marijuana frequently, as well as among the contexts of their marijuana use events. Future studies need to relate these event-level data to risk and morbidity. Interventions to reduce marijuana use among young frequent users need to consider these differences in both user and use and target both individual- and event-level factors related to severity of use.

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Highlights

- We use momentary sampling to characterize marijuana use among young frequent users
- We determine contextual and individual predictors of marijuana use severity
- We found diversity in social context, method, dose, and duration of marijuana use
- Contextual factors appear to predict marijuana dose for a given event
- Individual characteristics may be more predictive of high and duration of use

Table 1

Individual characteristics, contextual characteristics, and severity of marijuana use events among adolescents and young adults who frequently use marijuana

	n	%	M	SD	Range
<i>Individual characteristic^a</i>					
Age (years)			18.7	2.1	15–24
Female sex	23	58			
Age at first marijuana use (years)			13.7	2.4	6–19
Average frequency of marijuana use (times/week)			9.7	16.6	2–100
Poorer mental health ^b	27	68			
<i>Contextual characteristic^c</i>					
Companionship					
Alone	113	26.2			
Boyfriend/Girlfriend	65	15.0			
Parents, other family, other people	57	13.2			
Friends	197	45.6			
Location					
Home	252	58.3			
School, work, other place	88	20.4			
Friend's house	92	21.3			
Method					
Blunt	286	66.2			
Bong	50	11.6			
Ate it, vaporizer, other way	38	8.8			
Pipe	58	13.4			
Reason for use ^d					
For enhancement, expansion or social reason	369	85.8			
To cope or conform	61	14.2			
Time of day ^e					
6:00 – 11:59 am	35	8.1			
Noon – 5:59 pm	176	40.7			

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	n	%	M	SD	Range
6:00 – 11:59 pm	158	36.6			
Midnight – 5:59 am	63	14.6			
Time of week ^f					
Weekend	152	37.6			
Weekday	252	62.4			
Severity of marijuana use event ^c					
Dose					
6 or more hits	349	81.0			
1 – 5 hits	83	19.0			
Duration (minutes) ^g			46.8	66.5	0.63–672.5
Highest high (possible 0 – 8)			5.2	1.8	0–8

^aN = 40 individuals

^bIdentified on latent class analysis as having lower positive affect, higher negative affect, higher depressive symptoms, higher state anxiety, higher trait anxiety, and higher social anxiety.

^cN = 432 events, unless otherwise noted.

^dN = 430 reports with a non-missing value for reason for use.

^eN = 404 reports with a non-missing value for time of day.

^fExcludes events occurring on a Friday for which time of use was not reported (n=28).

^gIncludes events with both start and end time (n=250).

Table 2
Individual and contextual characteristics associated with dose of marijuana per a given use event ^a

Dose (6 or more hits vs. 1–5 hits)						
	Bivariate Models			Multivariate Model		
	OR	95% CI	p	AOR	95% CI	p
<i>Individual characteristic</i>						
Age (years)	0.95	0.76, 1.89	0.65	0.98	0.81, 1.20	0.87
Female sex	0.53	0.20, 1.39	0.18	0.45	0.15, 1.29	0.14
Age at first marijuana use (years)	0.88	0.76, 1.02	0.14	0.92	0.78, 1.09	0.39
Average frequency of marijuana use (times/week)	1.00	0.98, 1.02	0.73	1.01	0.99, 1.03	0.29
Poorer mental health <i>b</i>	2.81	1.14, 6.93	0.04 *	3.77	1.65, 8.64	0.007 *
<i>Contextual characteristic</i>						
Companionship			0.68			0.73
Alone	0.70	0.37, 1.31	0.26	0.86	0.39, 1.92	0.72
Boyfriend/Girlfriend	0.72	0.38, 1.36	0.32	0.60	0.23, 1.55	0.29
Parents, other family, other people	0.91	0.53, 1.58	0.74	1.24	0.53, 2.90	0.61
Friends	1.00	Referent	----	1.00	Referent	----
Location			0.53			0.51
Home	0.75	0.48, 1.17	0.21	0.69	0.32, 1.50	0.35
School, work, other place	0.77	0.41, 1.45	0.42	0.48	0.16, 1.49	0.21
Friend's house	1.00	Referent	----	1.00	Referent	----
Method			0.02 *			0.02 *
Blunt	3.87	2.02, 7.42	<0.001 *	5.25	2.28, 12.08	<0.001 *
Bong	2.79	1.01, 7.71	0.049 *	5.81	1.86, 18.13	0.003 *
Ate it, vaporizer, other way	1.44	0.59, 3.52	0.42	1.77	0.57, 5.48	0.32
Pipe	1.00	Referent	----	1.00	Referent	----
Reason for use						
For enhancement, expansion or social reason	0.83	0.52, 1.33	0.49	0.78	0.47, 1.31	0.36
To cope or conform	1.00	Referent	----	1.00	Referent	----
Time of day			0.09			0.01 *

Dose (6 or more hits vs. 1–5 hits)					
Bivariate Models			Multivariate Model		
OR	95% CI	p	AOR	95% CI	p
6:00 – 11:59 am	1.81 0.89, 3.70	0.10	3.23 1.27, 8.22	0.014*	
Noon – 5:59 pm	1.41 0.86, 2.32	0.17	1.23 0.62, 2.44	0.56	
6:00 – 11:59 pm	2.03 1.28, 3.23	0.003*	2.65 1.40, 5.00	0.003*	
Midnight – 5:59 am	1.00 Referent	-----	1.00 Referent	-----	
Time of week					
Weekend	1.59 1.10, 2.31	0.03*	2.13 1.35, 3.38	0.0006*	
Weekday	1.00 Referent	-----	1.00 Referent	-----	

^aN = 404 events, owing to missing data.

^bIndividuals identified on latent class analysis as having lower positive affect, higher negative affect, higher depressive symptoms, higher state anxiety, higher trait anxiety, and higher social anxiety.

Note: OR = odds ratio. AOR = adjusted odds ratio. CI = confidence interval.

* indicates statistically significant at the 0.05 level. *p*-values for overall test of effect are from a Type III GEE dichotomous outcome analysis (chi-square). Individual comparisons within effects are from a chi-square test with 1 degree of freedom. Each AOR is adjusted for all other covariates listed in the table.

Table 3

Individual and contextual characteristics associated with highest high experienced from a given marijuana use event ^a

	Highest high (from 0 to 8)			
	Bivariate Models		Multivariate Model	
	Estimate	SE	Estimate	SE
<i>Individual characteristic</i>				
Age (years)	-0.17	0.09	0.07	0.08
Female sex	0.04	0.39	0.93	0.43
Age at first marijuana use (years)	-0.04	0.07	0.60	0.09
Average frequency of marijuana use (times/week)	-0.01	0.01	0.57	0.01
Poorer mental health ^b	1.05	0.35	0.01 *	0.31
<i>Contextual characteristic</i>				
Companionship			0.06	
Alone	-0.22	0.26	0.40	0.26
Boyfriend/Girlfriend	-0.36	0.19	0.07	0.19
Parents, other family, other people	-0.68	0.24	0.0049 *	0.29
Friends	Referent	---	Referent	---
Location			0.76	0.58
Home	-0.20	0.32	0.53	0.28
School, work, other place	-0.18	0.23	0.42	0.22
Friend's house	Referent	---	Referent	---
Method			0.13	0.07
Blunt	0.72	0.30	0.02 *	0.29
Bong	0.39	0.31	0.20	0.38
Ate it, vaporizer, other way	0.34	0.39	0.39	0.38
Pipe	Referent	---	Referent	---
Reason for use				
For enhancement, expansion or social reason	0.02	0.35	0.95	0.33
To cope or conform	Referent	---	Referent	---
Time of day			0.53	0.38

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	Highest high (from 0 to 8)					
	Bivariate Models			Multivariate Model		
	Estimate	SE	P	Estimate	SE	P
6:00 – 11:59 am	−0.30	0.37	0.43	−0.21	0.40	0.60
Noon – 5:59 pm	−0.40	0.23	0.08	−0.41	0.21	0.05
6:00 – 11:59 pm	−0.37	0.26	0.15	−0.39	0.22	0.08
Midnight – 5:59 am	Referent	----	----	Referent	----	----
Time of week						
Weekend	0.01	0.21	0.96	−0.001	0.20	0.99
Weekday	Referent	----	----	Referent	----	----

^aN = 401 events, owing to missing data.

^bIndividuals identified on latent class analysis as having lower positive affect, higher negative affect, higher depressive symptoms, higher state anxiety, higher trait anxiety, and higher social anxiety.

Note.

^{*} indicates statistically significant at the 0.05 level. *p*-values are from a Type III GEE continuous outcome analysis (chi-square). Each estimate is adjusted for all other covariates listed in the table.

Table 4
Individual and contextual characteristics associated with duration of a given marijuana use event ^a

	Duration (minutes)					
	Bivariate Models			Multivariate Model		
	Estimate	SE	P	Estimate	SE	P
<i>Individual characteristic</i>						
Age (years)	0.93	2.55	0.70	0.01	2.42	0.997
Female sex	28.87	10.74	0.02 *	24.35	10.36	0.04 *
Age at first marijuana use (years)	3.27	2.84	0.32	2.51	2.76	0.39
Average frequency of marijuana use (times/week)	0.13	0.23	0.66	0.20	0.26	0.59
Poorer mental health ^b	18.96	11.65	0.13	10.30	6.99	0.20
<i>Contextual characteristic</i>						
Companionship			0.21			0.37
Alone	-26.02	12.52	0.04 *	-24.99	14.77	0.09
Boyfriend/Girlfriend	-16.01	10.38	0.12	-17.19	9.10	0.06
Parents, other family, other people	-23.31	9.96	0.02 *	-18.30	10.63	0.09
Friends	Referent	----	----	Referent	----	----
Location			0.98			0.76
Home	-1.66	8.27	0.84	8.23	11.14	0.46
School, work, other place	0.47	9.05	0.96	1.58	9.67	0.87
Friend's house	Referent	----	----	Referent	----	----
Method			0.90			0.90
Blunt	7.27	12.23	0.55	11.76	16.08	0.46
Bong	4.76	13.88	0.73	5.03	14.99	0.74
Ate it, vaporizer, other way	1.79	13.33	0.89	5.87	15.07	0.70
Pipe	Referent	----	----	Referent	----	----
Reason for use						
For enhancement, expansion or social reason	17.47	10.28	0.20	9.79	9.61	0.35
To cope or conform	Referent	----	----	Referent	----	----
Time of day			0.61			0.79

	Duration (minutes)					
	Bivariate Models			Multivariate Model		
	Estimate	SE	P	Estimate	SE	P
6:00 – 11:59 am	2.20	11.37	0.85	-0.49	12.15	0.97
Noon – 5:59 pm	3.84	8.76	0.66	2.72	10.10	0.79
6:00 – 11:59 pm	11.42	9.63	0.24	8.96	10.79	0.41
Midnight – 5:59 am	Referent	----	----	Referent	----	----
Time of week						
Weekend	-0.005	6.28	0.999	-3.12	6.50	0.64
Weekday	Referent	----	----	Referent	----	----

^aN = 248 events with both start and end time (2 such events excluded owing to missing data).

^bIndividuals identified on latent class analysis as having lower positive affect, higher negative affect, higher depressive symptoms, higher state anxiety, higher trait anxiety, and higher social anxiety.

Note.

* indicates statistically significant at the 0.05 level. *p*-values are from a Type III GEE continuous outcome analysis (chi-square). Each estimate is adjusted for all other covariates listed in the table.