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Marijuana withdrawal and aggression among a representative sample of U.S. marijuana users

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Abstract

Background—Previous laboratory-based research suggests that withdrawal from marijuana may cause increased aggression. It is unclear whether this finding extends beyond the laboratory setting to the general population of marijuana users. The purpose of this study was to test a cross-sectional association between marijuana withdrawal symptoms and aggression among a representative sample of U.S. adult marijuana users, and to test whether this association was moderated by previous history of aggression.

Methods—Data were analyzed from the National Epidemiologic Survey on Alcohol and Related Conditions. Wave Two data (2004–2005) were used for all variables except for history of aggression, which was assessed during the Wave One interview (2001–2002). Two outcomes were examined: self-report general aggression and relationship aggression. Odds ratios for aggression based on withdrawal symptoms and the interaction between withdrawal symptoms and history of aggression were calculated using logistic regression, adjusting for covariates and accounting for the complex survey design.

Results—Among marijuana users with a history of aggression, marijuana withdrawal was associated with approximately 60% higher odds of past year relationship aggression ($p < 0.05$). There was no association between withdrawal symptoms and relationship aggression among those without a history of aggression, and no association with general aggression regardless of history of aggression.

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Contributors

Authors PHS, GGH, KEL and RLC all contributed to the design of the study. PHS conducted the analyses and wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Conflicts of Interest

All authors declare that they have no conflicts of interest.

Conclusions—The findings from this study support the notion that laboratory-based increases in aggression due to marijuana withdrawal extend to the general population of marijuana users who have a previous history of aggression.

Keywords

marijuana; withdrawal; aggression; cannabis; THC; NESARC

1. INTRODUCTION

Researchers and policy makers have long debated the relation between marijuana use and aggression (Taylor and Hulsizer, 1998). To date, a large body of research has examined this relationship using pre-clinical animal samples (Cherek and Thompson, 1973; Kilbey et al., 1973; Miczek et al., 1994), human experimental studies (Cherek and Dougherty, 1995; Cherek et al., 1993; Myerscough and Taylor, 1985), and observational study designs (Arseneault et al., 2000; Hammer and Pape, 1997; Sussman et al., 1996). Pre-clinical animal studies tend to find that delta-9-tetrahydrocannabinol (THC) administration either has a null or inhibitory effect on aggressive behavior (Cherek and Thompson, 1973; Miczek and Barry III, 1974). Human experimental studies have found both null results and positive associations (Cherek and Dougherty, 1995; Cherek et al., 1993; Myerscough and Taylor, 1985; Taylor et al., 1976), and are thus inconclusive (Moore and Stuart, 2005).

Findings from observational research are largely mixed. For example, Arseneault et al. (1996) conducted a study of mental disorders and violence among 961 members of the 1972–1973 New Zealand birth-cohorts, and found that those who reported violent crime were approximately four times more likely to report marijuana dependence than those who were not violent. Conversely, White et al. (1999) conducted a longitudinal investigation of substance use and aggression among 506 males from 7th to 12th grade, and found that the predictive association between marijuana use and aggression was non-significant after controlling for history of aggression and alcohol use. Multiple researchers have summarized these findings in empirical reviews, and due to the inconsistent nature of the results, have come to varying conclusions (Hoaken and Stewart, 2003; Moore and Stuart, 2005; Sussman et al., 1996; Taylor and Hulsizer, 1998).

The majority of previous research on the topic of marijuana and aggression has focused on marijuana use as the behavior of interest; however, marijuana may be tied to aggression through withdrawal symptoms (Hoaken and Stewart, 2003; Moore and Stuart, 2005). There is a growing body of empirical evidence that a portion of heavy marijuana users experience substantial changes in mood and behavior during periods of abstinence, including symptoms of irritation and aggression (Budney and Hughes, 2006; Budney et al., 2004, 2003, 1999; Haney et al., 1999; Kouri et al., 1999). For example, Kouri et al. (1999) conducted a laboratory experiment among heavy, chronic marijuana users, in which participants were randomized to control or abstinence conditions. The abstinence group exhibited higher levels of aggression at days three and seven when compared to the control group and to their pre-abstinence aggression levels. Allsop et al. (2011) measured cannabis withdrawal among 49 dependent cannabis users with the Cannabis Withdrawal Scale, and found that withdrawal-related angry outbursts were intense and associated with high levels of distress.

These previous studies of marijuana withdrawal have been conducted in highly controlled experimental settings using samples of chronic marijuana users, and it is unclear whether marijuana withdrawal may be related to aggression in the general population of marijuana users using observational study designs. The effect of marijuana withdrawal on aggression found in laboratory studies may not be discernible in the context of the many other

inhibiting and facilitating factors in observational research settings (Leonard, 1993; Moore and Stuart, 2005). Further, it may be the case that although marijuana withdrawal increases aggressive responding in laboratory settings among chronic marijuana users, other risk factors for aggression moderate the association in observational studies of community or population samples. One important potential moderator is the general tendency to be aggressive (Chermack and Giancola, 1997; White and Hansell, 1996). A history of aggression strongly predicts the recurrence of current aggression (Elbogen and Johnson, 2009; Monahan and Steadman, 1996), and marijuana withdrawal symptoms may be more strongly related to aggression among those who have acted aggressively in the past.

1.1 General Aggression versus Relationship Aggression

The impact of marijuana withdrawal on general aggression can be placed in the context of Anderson and Bushman's (2002) heuristic model of general aggression. In this model, inputs from both person factors (e.g., traits, gender, beliefs, attitudes) and situational factors (e.g., aggressive cues, provocations) interact to create a person's present internal state, which then influences the behavioral outcome of a situation. One of the primary "present internal states" in this model is the individual's affect. Hostility, anger, and other negative affective states are strongly linked to aggression. Thus, if a smoker is experiencing these affective states as a result of their withdrawal, this individual may be more likely to act aggressively in a given circumstance.

A similar pathway may link marijuana withdrawal to relationship aggression. However, evidence suggests that there are important differences between general aggression and partner aggression with regard to their risk factors and etiology (Babcock et al., 2003; Moffitt et al., 2000). For example, general aggression is often rooted in a pattern of antisocial behavior. While this is true for a portion of those who act aggressively towards their romantic partners, a larger proportion of relationship aggression results from poor conflict resolution tactics that are not the result of antisocial tendencies (Kelly and Johnson, 2008). This is reflected in a study by Moffitt et al. (2000) who found that negative emotionality increased propensity for both relationship aggression and general crime, while low constraint, a symptom of antisocial personality, was only found among perpetrators of general crime. It is important to note that this study examined general crime, and not aggression, although the findings likely extend to general aggression as crime and aggression are often both rooted in antisocial behaviors. Given these differences in etiology, it is reasonable to hypothesize that associations with marijuana withdrawal may differ between relationship aggression and general aggression, although these differences have not been previously studied.

1.2 Objectives

The current study examined whether marijuana withdrawal symptoms were associated with reports of general and relationship aggression in a U.S. nationally representative sample of marijuana users. We examined these associations using data from Wave Two of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), while adjusting for relevant covariates. We also tested the interaction between withdrawal symptoms and a history of aggression. Given that differences between relationship aggression and general aggression with regard to substance use withdrawal have not been empirically examined, we hypothesized significant associations with both outcomes. We also hypothesized that the associations would be stronger for those with a history of aggression.

2. METHODS

A detailed account of the NESARC methodology can be found elsewhere (Grant and Kaplan, 2005; Grant et al., 2003). Briefly, the Wave One NESARC data were collected during 2001 and 2002, and Wave Two during 2004 and 2005. The response rate for Wave One was 81%, and the sample of 43,093 represented the civilian, non-institutionalized adult population in the United States. Wave Two included 34,653 (80%) of the original respondents. For both waves, surveys were administered face-to-face, using computer-assisted personal interviews. African Americans, Hispanics, and young adults were oversampled, and the data were weighted to adjust for non-response at the household and person levels. Based on the 2000 Census, the data were adjusted on socio-demographic variables to ensure an accurate representation of the U.S. population. We chose to examine aggression reported at Wave Two of the NESARC survey as our outcome because relationship aggression was assessed in more detail at Wave Two than during the Wave One interview.

We limited the sample to respondents who reported marijuana use at the Wave Two interview. This was done to generate a comparison group that was functionally similar to the exposure group (marijuana users with withdrawal symptoms compared to marijuana users without withdrawal symptoms). In the NESARC survey, relationship aggression was measured as past year occurrence, and general aggression was measured as occurrence since the Wave One interview; thus, when relationship aggression was the outcome of analyses, we limited the sample to those who reported marijuana use during the past year and reported being in a relationship ($n = 1,461$). When general aggression was the outcome, we limited the sample to those who reported marijuana use since the Wave One NESARC interview ($n = 1,712$). The sample was limited in this fashion to maintain a consistent time-frame between the marijuana withdrawal exposure variables and the aggression outcome variables. Past year marijuana users were similar to those who used since the last interview with regard to age (means = 34.47 and 34.31 years, respectively), gender (percent female = 32.3 and 32.4), household income (means = 10.34 and 10.39; representing the income range of \$35,000 to \$50,000), and education level (means = 9.77 and 9.82; between high school/GED and some college).

2.1 Measures

2.1.1 General Aggression—General aggression was assessed in the Wave Two NESARC survey as part of the Alcohol Use Disorder and Associated Disabilities Interview Schedule-DSM-IV version (AUDADIS-IV; Grant and Dawson, 2000) measure for Antisocial Personality Disorder. Four items assessed physical aggression since the previous interview: 1) hit someone so hard that you injured them or they had to see a doctor, 2) physically hurt another person in any way on purpose, 3) got into a lot of fights that you started, and 4) used a weapon like a stick, knife, or gun in a fight. Responses for these items were yes/no. For the purposes of this investigation, we created a binary variable in which we classified an affirmative response to any one of these four items as a report of general aggression. We chose a binary classification over a count variable because of substantial overlap between the four items. Sensitivity analyses showed that the nature of our findings did not vary by classification scheme, and the binary variable was simpler for purposes of analyses and interpretation. A similar binary measure was utilized by Elbogen and Johnson (2009), who demonstrated that this operationalization of aggression related to dispositional, historical, and contextual risk factors for aggressive behavior, supporting the validity of the measure.

2.1.2 Relationship Aggression—Relationship aggression was assessed in the Wave Two NESARC interview by asking how often the respondent perpetrated the following actions during the past year: 1) push, grab or shove your spouse/partner, 2) slap, kick, bite, or hit your spouse/partner, 3) threaten your spouse/partner with a weapon like a knife or gun, 4) cut or bruise your spouse/partner, and 5) injure your spouse/partner enough that they had to get medical care. For this study, we combined responses to the five perpetration questions into a single binary variable representing whether the respondent perpetrated IPV during the past year. There were several reasons for this decision. First, the response options included “never”, “once”, and “twice”, but then skipped to “monthly” and “more than monthly”, which precluded summing them for a frequency of aggression measure. In addition, two items assessed physically aggressive acts, and two items were directed at injuries due to violence. It was necessary to include the injury items because they might capture additional aggressive acts, but they could not simply be added to the frequency of the aggressive acts because it could constitute double counting for some individuals. For example, a hit that left a bruise might be counted as two items. As a consequence, the more valid approach was to simply indicate whether any relationship aggression had occurred.

2.1.3 Marijuana Withdrawal—Symptoms of marijuana withdrawal were assessed as part of the AUDADIS-IV measure. This tool assesses both abuse and dependence diagnoses for alcohol and other specific substances. The interview was structured so that the same questions were asked for all illicit substances covered. Thus, although the DSM-IV does not include a marijuana withdrawal syndrome diagnosis, the interview addressed marijuana withdrawal symptoms. Questions regarding withdrawal symptoms were preceded with the following prompt: “Have you had any of the following bad aftereffects when the effects of a medicine or drug were wearing off? This includes the morning after using it or in the first few days after stopping or cutting down on it.” We selected the following symptoms for the current study based on previous empirical findings: irritation, depression, anxiety or nervousness, restlessness, disturbed sleep (insomnia, hypersomnia or unpleasant dreams), and decreased appetite (Budney et al., 2004, 2003). We created binary withdrawal variables for these analyses (past year withdrawal and withdrawal since the last interview). Given that there is no currently accepted number of symptoms for clinically relevant marijuana withdrawal, we originally explored a cut-off of three or more symptoms, as this is the level used to classify DSM-IV withdrawal syndromes for other illicit substances. This cut-off did not result in sufficient sample size of users classified with withdrawal, resulting in our use of a slightly less stringent cut-off of two or more symptoms. This cut-off approximately represented the 90th percentile among all marijuana users, and the 50th percentile among marijuana users reporting any withdrawal symptoms. The number of DSM-IV substance abuse/dependence symptoms endorsed is typically considered to be a continuum of severity (Martin et al., 2008). Thus, using a cut-off of two or more symptoms likely represented less severe withdrawal than a higher cut-off point. We also considered a count variable of symptoms; however, the distributions of the count variables were highly skewed and the interpretation of results did not substantially vary between the binary and count variables.

2.1.4 History of Aggression—As part of the Wave One interview, respondents answered the same four general aggression questions that we used for our measure of Wave Two general aggression. However, at Wave One the respondents were asked whether the aggression occurred prior to the age of 15 or since the age of 15. We created a history of aggression variable based on whether the respondents reported general aggression since the age of 15. Those who reported aggression prior to the age of 15 but not afterwards were considered to have no history of aggression for these analyses, because late adolescent/adult aggression was a stronger predictor of aggression at Wave Two than childhood/early adolescent aggression.

2.1.5 Covariates—We based our final selection of covariates on conceptual knowledge of potential confounding variables, as well as an assessment of a variable’s impact on the odds ratio for the association between marijuana withdrawal and aggression. The following covariates were included in analyses for both general and relationship aggression: age, gender, household income, education, marijuana use [a quantity by frequency variable (QxF)], antisocial symptoms (other than aggression), alcohol use disorder, and drug use disorder (other than marijuana). Race/ethnicity and a serious mental illness diagnosis were also examined as covariates, but were not included in the final model because they did not substantially alter the odds ratio for the association between marijuana withdrawal and aggression. The drug and alcohol use disorder variables were binary and represented whether the respondent was diagnosed with abuse, dependence, or both.

To measure marijuana use, we created two QxF variables: one for past year use and the second for use since the last interview. Usual quantity was assessed in the NESARC survey by asking marijuana users, “On the days that you used marijuana (in the last 12 months/ since the last interview), about how many joints or joint equivalents did you usually smoke in a single day?”. Frequency of marijuana use was assessed by asking, “Since your last interview/In the last 12 months about how often did you use marijuana?” Responses were categorized into ten groups, with one representing “Once a year” and ten representing “Every day.” Quantity of use was multiplied by frequency of use to create the marijuana use QxF variables. The resulting variables had a range of 1 to 220.

The measure of antisocial personality included symptoms from the AUDADIS-IV measure of Antisocial Personality Disorder, other than the aggression items used in our measure of general aggression. Symptoms included controlling, manipulative behaviors (e.g., trying to intimidate others, frequent lies, harassing, black mailing), criminal behaviors (e.g., scamming for money, stealing, damaging property of others), and careless behavior (e.g., driving recklessly).

2.2 Overview of Data Analyses

All analyses were adjusted based on the complex NESARC study design. Marijuana users who reported two or more withdrawal symptoms were compared to marijuana users who reported less than two withdrawal symptoms using descriptive statistics, chi-square tests of independence and t-tests. Logistic regression models were employed to generate odds ratios for reports of aggression based on whether the marijuana user endorsed two or more withdrawal symptoms. We calculated two series of models: one with general aggression as the outcome and the second with relationship aggression as the outcome. The first model in each series consisted of main effects only, testing for the association between withdrawal symptoms and aggression while adjusting for covariates. In the second models, we added the interaction of withdrawal symptoms and history of aggression. In the third models, due to overlap between the relationship aggression and general aggression variables, we included general aggression as a covariate in the relationship aggression model, and vice versa. Contingent on significant interaction terms, we used simple slope analyses to assess the moderated associations between withdrawal symptoms and aggression.

3. RESULTS

3.1 Prevalence of Withdrawal Symptoms

Two or more withdrawal symptoms were reported by 9.8% of past year marijuana users and 18.8% of those who used anytime between Wave One and Wave Two. Among the sub-sample of marijuana users reporting two or more symptoms, the following frequencies of symptoms were reported (for past year users and those who used since the last interview,

respectively): slept more (48.8%, 51.6%); felt anxious or nervous (50.9%, 44.5%); felt depressed (55.3%, 40.4%); became irritated (41.4%, 36.4%); insomnia (39.3%, 28.1%); restlessness (36.8%, 25.5%); unpleasant dreams (29.2%, 25.3%); and decreased appetite (29.1%, 19.6%).

3.2 Description of Those Reporting Two or More Withdrawal Symptoms

We used chi-square tests of independence and t-tests to assess differences between marijuana users with two or more withdrawal symptoms and those who reported one or zero symptoms (Table 1). Marijuana users who reported withdrawal symptoms used more frequently and in greater quantities, were younger, reported lower income, and reported lower education than those classified as non-withdrawal ($p < 0.001$). Past year marijuana users who were in a relationship and reported withdrawal were more likely to be female ($p < 0.001$). With regards to psychiatric co-morbidity and history of aggression, users with withdrawal had a greater number of antisocial symptoms, were more likely to be diagnosed with alcohol and other drug use disorders, and were more likely to have a history of aggressive behavior ($p < 0.001$). Marijuana users reporting withdrawal were more likely to report both general and relationship aggression than the non-withdrawal comparison group ($p < 0.001$).

3.3 Marijuana Withdrawal and Aggression

Marijuana withdrawal symptoms were not significantly associated with either general aggression or relationship aggression after adjusting for marijuana use QxF, age, gender, education, household income, antisocial symptoms (other than aggression), alcohol use disorders, and drug use disorders (other than marijuana; Tables 2 and 3). The interaction between marijuana withdrawal and history of aggression was statistically significant in the relationship aggression model ($p < 0.05$; Table 2). This interaction was not significant in the general aggression model ($p > 0.05$). Our probing of the interaction between history of aggression and withdrawal symptoms in the relationship aggression model showed that withdrawal was associated with a 59% increase in the odds of reporting relationship aggression among those with a history of aggression (OR = 1.59, 95% CI = 1.14, 2.22; Figure 1).

4. DISCUSSION

We tested whether withdrawal symptoms were associated with general and relationship aggression among a representative sample of U.S. adult marijuana users. Given the evidence that aggression is often recurrent, and those with a history of aggression may be particularly susceptible to the impact of substance use on aggression, we also tested whether a history of aggression moderated the association between withdrawal symptoms and current aggression. We found marijuana withdrawal symptoms were associated with current relationship aggression among users with a history of aggression. This finding was significant after adjusting for sociodemographic characteristics, marijuana use QxF, antisocial symptoms (other than aggression), alcohol use disorders, drug use disorders (other than marijuana), and general aggression. Withdrawal symptoms were not associated with relationship aggression among those with no history of aggression. The association with general aggression was non-significant after controlling for relationship aggression regardless of history of aggression, suggesting that marijuana withdrawal may be more strongly tied to relationship aggression than general aggression in population samples.

One explanation for the differential findings between relationship aggression and general aggression stems from the transitive nature of marijuana withdrawal. Previous research suggests that marijuana withdrawal symptoms peak after two to six days of abstinence, and

may last up to two weeks (Budney et al., 2003). Individuals tend to interact more frequently with their partner than others, and hence may be more likely to interact with their partner during periods of withdrawal. A second explanation is that aggression rooted in antisocial behavior is relatively stable over time (Kelly and Johnson, 2008), and heightened negative affect associated with marijuana withdrawal may not be substantial enough to influence whether or not an individual is generally aggressive in a given period of time after accounting for stronger risk factors (e.g., antisocial behavior). It is important to clarify that these results do not mean marijuana withdrawal is not a contributing factor to general aggression for particular individuals. It is certainly possible that individuals who have a tendency to be aggressive are more likely to act aggressively during periods of marijuana withdrawal than other periods, and this would not be captured by our binary classification of aggression. Research methods such as intensive longitudinal data collection (e.g., Ecological Momentary Assessment; EMA) are better suited for assessing these within-person effects.

We conceptualized marijuana use QxF as a covariate in these analyses rather than an exposure of interest, as there are a number of investigations examining cross-sectional and longitudinal associations between marijuana use and aggression. Still, it is important to note that marijuana use QxF, was associated with slightly higher odds of reporting general aggression (a quartile increase in the quantity by frequency variable, which ranged from 1 to 220, was associated with approximately 50% higher odds of reporting aggression). This may seem contrary to several investigations that have concluded marijuana use is not associated with aggressive behavior. However, these investigations typically assessed aggression among marijuana users relative to non-users, whereas our investigation examined users scoring higher on the QxF variable to users scoring lower on the variable. Marijuana use may be related to aggressive behavior for particular sub-groups of heavy users, and this effect could go undetected when comparing users to non-users. Chronic marijuana users may experience increased risk of aggression during periods of abstinence, but their withdrawal may be sub-clinical, or they may not attribute experiences of mood change to their abstinence in the self-report measures such as that utilized in this investigation. A second possible explanation is that the association with higher scores on the marijuana use QxF variable was a result of residual confounding from un-captured variance related to sociodemographic risk factors, psychopathological risk factors, and measurement error. This could explain why we found this association for general aggression and not relationship aggression, as general aggression is more strongly tied to antisocial psychopathology than relationship aggression (Moffitt et al., 2000).

The findings for a positive association between marijuana withdrawal and relationship aggression among those with a history of aggression may also be explained by aggression-reducing effects of marijuana. As previously noted, pre-clinical investigations have found that THC administration may decrease aggressive responding (Taylor and Hulsizer, 1998). Aggressive individuals may suppress aggressive tendencies with marijuana use, and thus be more likely to become aggressive during periods of abstinence from marijuana. This alternative explanation cannot be ruled out by the current investigation or previous laboratory studies, given a lack of longitudinal studies to examine this effect.

This study has important limitations that should be noted. The analyses were cross-sectional and were unable to establish a temporal link between the marijuana withdrawal symptoms and physical aggression. Thus, we cannot rule out the possible alternative explanation that marijuana users who were aggressive were more likely to report withdrawal symptoms. If this is the case, it is unclear why marijuana withdrawal was associated with aggression for only those with a history of aggression; if those who were aggressive were simply more likely to report withdrawal symptoms it seems we would have found significant associations regardless of history of aggression. It will be important for future research to utilize methods

such as real-time data collection (e.g., EMA) to further explore the temporal aspects of this association. Due to the highly correlated nature of withdrawal symptoms in this dataset, we could not identify which specific symptoms were most strongly associated with aggression. Real-time data collection methods would also be useful for examining this research question. A related limitation is that the respondents were asked to recall marijuana withdrawal and acts of aggression over the past year for relationship aggression, and over the past three years for general aggression, resulting in the potential for recall bias. Recall bias would be present if those reporting marijuana withdrawal were more likely to recall their aggressive acts than those who did not report withdrawal. Given that physical aggression is a highly memorable event, and our aggression measures were binary, it is unlikely that recall bias substantially influenced the findings. Lastly, it is unlikely that the aggression measures utilized in the NESARC survey captured all aggressive respondents, due to both underreporting and limitations of the aggression items themselves. However, the findings from this and other investigations utilizing the NESARC (Elbogen and Johnson, 2009; Van Dorn et al., 2011) data suggest that the items capture a valid and meaningful sample of aggressive individuals.

In conjunction with the evidence from laboratory research that withdrawal from marijuana use can result in increased aggression among chronic marijuana users, these results suggest a need for further research on the underlying mechanisms that contribute to an association between marijuana withdrawal and aggression. Further research is also needed to assess the clinical relevance of an association between marijuana withdrawal and aggression among those with a history of aggression, and whether withdrawal-related aggression impedes the cessation attempts in this sub-group.

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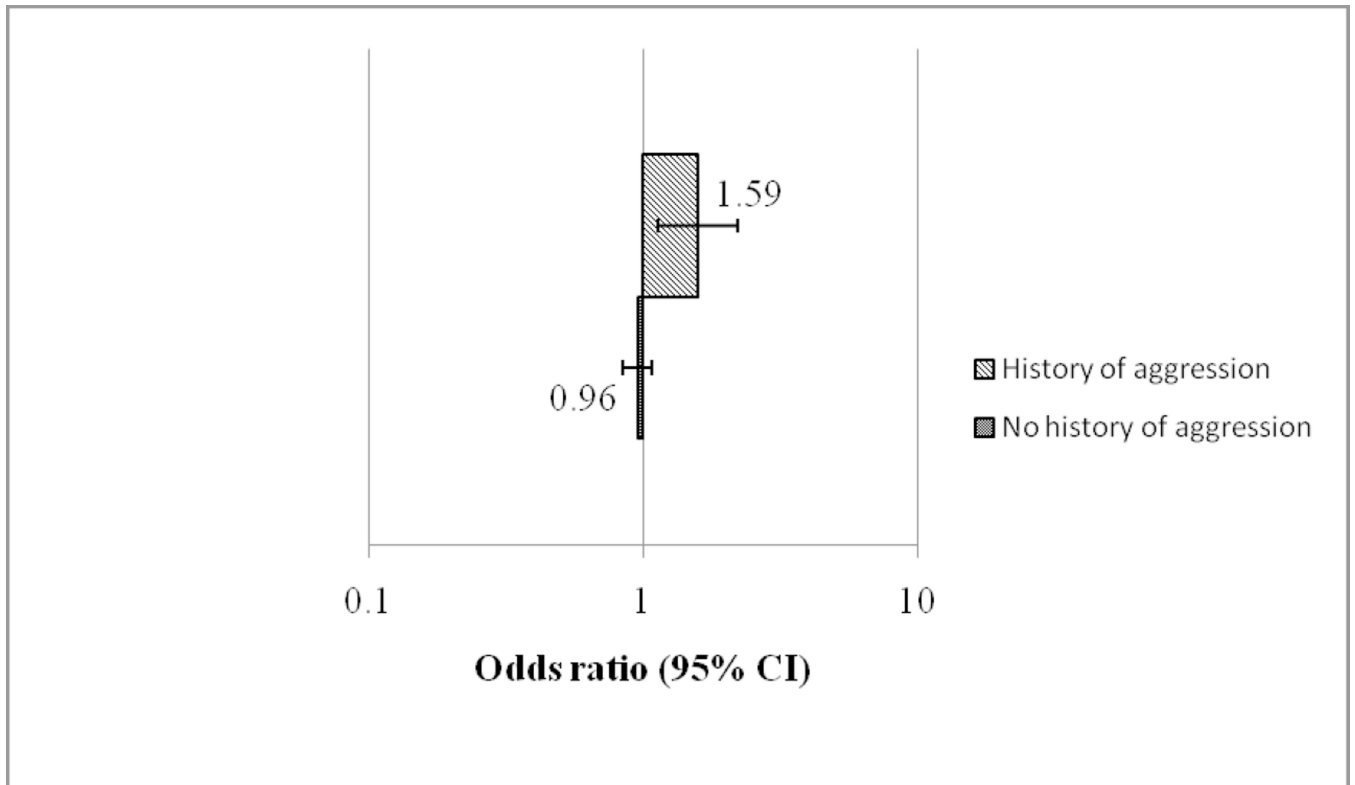


Figure 1.

History of aggression moderated the association between marijuana withdrawal and relationship aggression. Odds ratio estimates were based on logistic regression modeling and were adjusted for quantity by frequency of marijuana use, age, gender, household income, education, antisocial symptoms (other than aggression), alcohol use disorder diagnoses, drug use disorder diagnoses (other than marijuana), and general aggression. The estimates were calculated accounting for the survey design.

Table 1

Characteristics of marijuana users, broken down by experience of withdrawal symptoms

	Used marijuana since the Wave One interview ^a (n=1,712) ^b		Used marijuana in the past year, in a relationship (n = 1,187) ^b	
	< 2 withdrawal symptom (n=1,386)	2 withdrawal symptoms (n=326)	< 2 withdrawal symptom (n= 1,071)	2 withdrawal symptoms (n=116)
Quantity by Frequency of marijuana use				
(Range 1 to 220) [mean (SE)]	8.80 (0.16)	15.35 (0.85)	8.81 (0.19)	15.83 (1.80)
Age [mean (SE)]	34.85 (0.16)	31.95 (0.21)	34.46 (0.16)	31.63 (0.28)
Gender				
Female	32.3%	32.6%	33.6%	45.3%
Male	67.7%	67.4%	66.4%	54.7%
Household income ^c	10.54 (0.05)	9.74 (0.13)	10.77 (0.06)	9.45 (0.15)
Education ^d	9.89 (0.02)	9.54 (0.04)	9.89 (0.03)	9.45 (0.05)
Antisocial Personality				
Disorder	13.3%	25.5%	14.9%	26.7%
History of aggression	10.2%	13.5%	10.6%	15.7%
Alcohol use disorder	50.4%	67.8%	43.9%	67.7%
Drug use disorder	13.0%	25.1%	7.9%	9.5%
General aggression	7.9%	14.7%	---	---
Relationship aggression	---	---	14.5%	23.2%

Note. Estimates accounted for the sampling design. Comparisons were made within those who used marijuana since the Wave One interview and those who used in the past year using chi-square tests of independence and t-tests. All differences were significant at the $p < 0.001$ level.

^aThe Wave One interview was administered during 2001–2002, and the Wave Two interview was administered during 2004–2005.

^bSample sizes were not adjusted for the survey design. Mean, standard error and percentage estimates were adjusted for the survey design.

^cHousehold income was measured from 1 to 21, representing categories from < \$5,000 to \$200,000. The value 9 represented \$30,000 to \$34,999, 10 represented \$35,000 to \$39,000, and 11 represented \$40,000 to \$49,000.

^dEducation was measured from 1 to 14, representing categories from No formal schooling to Completed Master's degree or higher graduate degree. A value of 9 represented Graduate equivalency degree and 10 represented Some college (no degree).

Table 2

The association between marijuana withdrawal symptoms and relationship aggression: Logistic regression results

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Withdrawal (2 or more symptoms)	1.04 (0.87, 1.24)	0.95 (0.77, 1.18)	0.95 (0.76, 1.17)
History of aggression	1.06 (0.93, 1.21)	0.98 (0.86, 1.11)	0.96 (0.85, 1.08)
Withdrawal X History of aggression	---	1.62 (1.04, 2.51) *	1.69 (1.11, 2.57) *
General aggression	---	---	1.34 (1.15, 1.56) ***
Quantity by Frequency of marijuana use (range: 1 to 220)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)
Age	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)
Female gender	3.80 (3.20, 4.50) ***	3.82 (3.23, 4.52) ***	3.91 (3.29, 4.63) ***
Household income	0.96 (0.94, 0.97) ***	0.96 (0.94, 0.97) ***	0.96 (0.94, 0.97) ***
Education	0.78 (0.75, 0.82) ***	0.78 (0.75, 0.82) ***	0.78 (0.75, 0.82) ***
Antisocial symptoms (other than aggression)	1.10 (1.08, 1.12) ***	1.10 (1.08, 1.12) ***	1.08 (1.06, 1.11) ***
Alcohol use disorder	1.68 (1.45, 1.94) ***	1.67 (1.45, 1.93) ***	1.68 (1.45, 1.94) ***
Drug use disorder (other than marijuana)	1.05 (0.87, 1.28)	1.06 (0.87, 1.29)	1.07 (0.88, 1.30)

Note. All estimates accounted for the survey design.

*
p < 0.05,

**
p < 0.01,

p < 0.001

Table 3

The association between marijuana withdrawal symptoms and general aggression: Logistic regression results

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Withdrawal (2 or more symptoms)	1.07 (0.82, 1.40)	0.97 (0.69, 1.36)	1.10 (0.87, 1.40)
History of aggression	1.47 (1.23, 1.75)***	1.27 (1.02, 1.57)*	1.59 (1.33, 1.92)***
Withdrawal X History of aggression	---	1.59 (1.00, 2.53)*	1.19 (0.80, 1.77)
Relationship aggression	---	---	1.29 (1.10, 1.51)**
Quantity by Frequency of marijuana use (range: 1 to 220)	1.01 (1.00, 1.01)**	1.01 (1.00, 1.01)**	1.01 (1.00, 1.02)***
Age	0.95 (0.94, 0.96)***	0.95 (0.94, 0.96)***	0.95 (0.94, 0.96)***
Female gender	0.95 (0.94, 0.96)***	0.57 (0.48, 0.68)***	0.52 (0.45, 0.61)***
Household income	1.01 (0.98, 1.04)	1.01 (0.98, 1.04)	1.00 (0.98, 1.02)
Education	0.78 (0.75, 0.82)***	0.78 (0.74, 0.82)***	0.83 (0.79, 0.86)***
Antisocial symptoms (other than aggression)	1.36 (1.32, 1.41)***	1.36 (1.32, 1.41)***	1.34 (1.30, 1.38)***
Alcohol use disorder	1.25 (1.03, 1.53)*	1.25 (1.03, 1.53)*	1.21 (1.03, 1.41)*
Drug use disorder (other than marijuana)	2.84 (1.51, 5.36)**	1.75 (1.42, 2.16)**	1.47 (1.26, 1.72)***

Note. All estimates accounted for the survey design.

* p < 0.05,

** p < 0.01,

*** p < 0.001