Association Between Marijuana Use and Condom Use: A Meta-Analysis of Between-Subject Event-Based Studies

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ABSTRACT. Objective: With the current public health burden of sexually transmitted infections, it is important to identify factors affecting condom use. The association between marijuana use and condom use is especially important because of the increasing number of U.S. states legalizing marijuana; however, relevant research findings are mixed. The goal of this study was to perform a meta-analysis assessing the relationship between marijuana and condom use at instances of sexual intercourse. **Method:** A systematic search of four databases was performed. Data were extracted and pooled estimates were calculated using random-effects models with inverse variance weighting. Heterogeneity was evaluated using the Cochran Q chi-square test. **Results:** Eleven studies were included. There was a statistically significant relationship between marijuana and condom use in the overall pooled analysis (odds ratio

[OR] = 0.71, 95% CI [0.56, 0.89]), and studies were homogeneous, $I^2 = 12\%$, $\chi^2(10) = 11.37$, $p = .33$. Stratified analyses showed that although the pooled OR was not significant for adults (OR = 0.92, 95% CI [0.64, 1.33]), there was a significant relationship between condom use and marijuana use for adolescents (OR = 0.62, 95% CI [0.47, 0.82]). **Conclusions:** This meta-analysis found that the odds of condom use were lower for those who used marijuana around the time of intercourse than for those who did not, with this effect only significant for adolescents in a subgroup analysis. As the adolescent populations in this analysis were not representative of a general population of adolescents, future research should focus not only on those considered high risk. (*J. Stud. Alcohol Drugs*, 79, 361–369, 2018)

SEXUALLY TRANSMITTED INFECTIONS (STIs) are a costly, burdensome, and sometimes deadly health problem in the United States (U.S. Department of Health and Human Services, 2018). STIs affect many Americans, with 19 million new cases every year (Weinstock et al., 2004). The Healthy People 2020 goals include decreasing rates of STIs and recommend condom use as one important method to prevent the spread of STIs (U.S. Department of Health and Human Services, 2018). Understanding correlates of condom use can improve the effectiveness of interventions to increase their use. One correlate that has been studied is alcohol consumption. A meta-analysis in 2002 found no overall association between alcohol use and condom use in studies that investigated the most recent instance of sexual intercourse but did identify a trend toward reduced condom use in adolescents (Leigh, 2002).

With the current legalization of recreational marijuana in nine U.S. states plus the District of Columbia and medical marijuana in an additional 21 states (Struyk, 2018), it is timely to consider the relationship between marijuana use and condom use. Marijuana is the most commonly used illicit drug in the United States; among those 12 years of age and older, 8.9% are current users of marijuana; the rate is 6.5% among those between ages 12 and 17 (Substance Abuse and Mental Health Services Administration, 2017). Marijuana use has been associated with receiving an STI diagnosis in the past year (Smith et al., 2010; Wu et al., 2009) and with risk behaviors such as having several sexual partners in the last year (Bellis et al., 2008; Smith et al., 2010). Some studies have found an association between marijuana use and decreased condom use (Anderson & Stein, 2011; Bellis et al., 2008; Boone et al., 2013), although others have not (Hensel et al., 2011; Smith et al., 2010). Research on partner type (e.g., casual partner, steady partner) has also produced conflicting results (Walsh et al., 2014). Studies have varied in design; some look at the global association between the behaviors (e.g., Bellis et al., 2008), whereas others examine daily diaries of participants' drug use and sexual behaviors (e.g., Walsh et al., 2014).

A meta-analysis can inform public health interventions to improve use of condoms, and other meta-analyses of condom use and substance use (Leigh, 2002; Shuper et al.,

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2009) have focused on alcohol. Knowing if, and for whom, marijuana use decreases the likelihood of condom use can be useful to program developers. This meta-analysis aimed to clarify whether marijuana use during intercourse decreases the likelihood of condom use. Given the mixed results in the literature, we posed no specific hypotheses.

As with a previous meta-analysis of substances and condom use (Leigh, 2002), we examined only event-based analyses—in other words studies in which respondents were asked to report their substance and condom use at a single instance of intercourse—rather than their substance and condom use patterns in general. As Leigh (2002) asserted, when compared with analyses that examine general patterns of use, analyses of single sexual events produce conclusions that are closer to causality regarding the impact of the substance on condom use, because the decision whether to use a condom is more likely to have actually occurred while under the influence of the substance.

Method

This review is registered through PROSPERO (ID: 42015017442). Studies for inclusion in this meta-analysis were identified through a search of four databases: PsycINFO, CINAHL, PubMed, and Embase, conducted in May 2016. An initial literature search was used to inform a search strategy based on keywords and terms, which was finalized with the assistance of two librarians experienced in systematic reviews. Terms included those for marijuana, for events of intercourse, and for condom use. For example, the PsycINFO search was as follows: (cannabi* OR hemp* OR marihuana* OR marijuana* OR ganja* OR hashish* OR bhang* OR “substance use*” OR “drug use*” OR “intoxicant use*”) AND (condom* OR unprotected OR protection OR protected OR unsafe OR contracept* OR birth control OR safe) AND (sex* OR intercourse* OR coitus OR coital) AND (first OR event* OR episode* OR recent OR last OR encounter* OR instance* OR occasion* OR incident* OR occurrence*). Searches for other databases are available on request from the first author.

Studies were included if they (a) measured condom use at a specific instance of intercourse, (b) measured marijuana use at the same instance of intercourse, and (c) examined the relationship between these two variables. Studies were excluded if they (a) were in a language other than English, (b) examined nonconsensual intercourse, (c) examined within-subject data (daily diary studies), (d) averaged results over several instances of intercourse, or (e) failed to measure marijuana separate from alcohol (e.g., alcohol or marijuana use at last intercourse). Daily diary studies, which examine within-subject variation in behaviors, and studies averaging results over multiple instances of intercourse were excluded in order to maintain consistency of outcomes, exposure definitions, and statistical methods. No populations were

excluded. Experts in the field were contacted to find studies that were missed through searching. The reference lists of each included article were examined for possible additional studies to include. Figure 1 contains a flowchart of the search strategy.

A data-extraction form was developed by the first author. Two reviewers filled out a form for each article, and the two versions of the form were compared by a third reviewer, with differences resolved by consensus. Data on the following variables were collected: location of study, study years, population, sampling strategy, data collection method, sample size, mean/median age, gender and race proportions, definitions of condom use and marijuana use, contingency tables, unadjusted and adjusted odds ratios (ORs) and confidence intervals (CIs), variables included as covariates, and a quality assessment tool. All analyses using the variables of interest were included in the data extraction, but only one estimate from each study was used in each pooled analysis. To assess study quality, we used a modified version of the Downs and Black quality assessment scale (Downs & Black, 1998). Irrelevant items were removed, and wording was changed to match the nature of the studies. A cutoff of 12 was used to define studies of good quality.

Extracted data were entered into Microsoft Excel 2013. ORs and CIs were calculated from raw data when available. For both crude and adjusted ORs, we calculated the natural log of the OR and the variance and pooled study results using Review Manager software (RevMan; The Cochrane Collaboration, 2014) with random-effects models (DerSimonian & Laird, 1986). For three studies (Kingree & Phan, 2002; Leigh et al., 2008; Sanders et al., 2010), adjusted estimates were only available for subsets of samples, and estimates for subsets were combined using fixed-effect meta-analysis before being entered into the overall analysis, as described by Borenstein et al. (2009). Inverse variance weighting was used, and the Cochran Q statistic and the I^2 statistic were used to examine heterogeneity in the overall pooled model and in the stratified analyses (Woolf, 1955). We planned and conducted three subgroup analyses: by gender; by age, as age was a marginally significant variable in a meta-analysis on alcohol (Leigh, 2002); and by adjusted or crude estimate status. The possibility of publication bias was assessed by examining a funnel plot for symmetry.

Results

Information on the 11 studies (described in 13 articles) that met the inclusion criteria is available in Table 1. All studies were conducted in the United States. Five studies used samples of adolescents (Bailey et al., 1998; Hendershot et al., 2010; Kingree & Betz, 2003; Kingree & Phan, 2002; Kingree et al., 2000), five used samples of adults (Leigh et al., 2008; McMahon et al., 2006; Sanders et al., 2010; Tucker et al., 2010, 2013), and one used a sample of youth with an

Figure 1. Study selection diagram

average age above 18 (Tucker et al., 2012). Two articles described studies already presented in other articles (Bryan et al., 2012; Dodge et al., 2010). Most studies examined high-risk populations. Two studies examined runaway youth or youth experiencing homelessness (Bailey et al., 1998; Tucker et al., 2012), and four examined youth in detention or on probation (Hendershot et al., 2010; Kingree & Betz, 2003; Kingree & Phan, 2002; Kingree et al., 2000). Two studies examined populations impacted by drug use who were either sex workers (McMahon et al., 2006) or in drug diversion classes (Leigh et al., 2008). One study used the general adult population (Sanders et al., 2010). The symmetry of the funnel plot in Figure 2 demonstrates that there is little to no evidence of publication bias, as there were published studies that had results on both sides of the pooled effect and the plot formed a funnel with studies.

Results for the overall meta-analysis are available in Figure 3. There was a statistically significant association, with lower odds of condom use among those who used marijuana at intercourse (OR = 0.71, 95% CI [0.56, 0.89]). The results were homogenous, $I^2 = 12\%$, $\chi^2(10) = 11.37$, $p = .33$.

We conducted three stratified analyses. Figure 4 presents the results stratified by gender. Studies were included if they either split results by gender or included only one gender in the sampling. The test for subgroup differences was not significant, $\chi^2(1) = 0.36$, $p = .55$, with both males (OR = 0.84, 95% CI [0.42, 1.72]) and females (OR = 0.62, 95% CI [0.31, 1.25]) showing a nonsignificant association between marijuana use and condom use. Although the subset of males demonstrated substantial heterogeneity, $I^2 = 60\%$, $\chi^2(3) = 7.44$, $p = .06$, the subset of females did not, $I^2 = 0\%$, $\chi^2(3) = 2.14$, $p = .54$.

TABLE 1. Characteristics of studies included in the meta-analysis

First author (year)	Type of sexual encounter	Definitions		Population	Sampling strategy	Location	Respondent				Quality total
		Condom use	Marijuana use				Gender	Percentage black	<i>M/Mdn</i> age	<i>n</i>	
Bailey (1998)	Most recent	Used	Used	Homeless or runaway youth	Purposive sampling	District of Columbia, U.S.	Both	>80%	17	189	13.5
Kingree (2000)	Most recent	Used	Used	Youth in detention centers	Stratified random sampling	Georgia	Both	66%	15.15	141	14.5
Kingree (2002)	First time with current or most recent partner	Used	3 hours preceding	Adolescent detainees in holding facility	Interviewers present over multiple weeks, varying days and times	Southeastern United States	Both	85%	14.82	205	16
Kingree (2003)	First time with current or most recent partner	Used	3 hours preceding	Males in juvenile detention facilities	Interviewers visited detention facilities weekly over 6-month period	Atlanta, GA	Males	100%	15.43	210	13.5
McMahon (2006)	Most recent sex exchange	Consistently used	Used	Female drug-using sex exchangers	Targeted sampling, referrals	East Harlem, NY	Females	57%	<i>Mdn</i> = 37	154	13.5
Leigh (2008)	Most recent with casual partner	Used	Before or during	Drug offenders in drug diversion classes	Random selection of classes	Los Angeles, CA	Both	M: 5% F: 14%	<i>Mdn</i> = 30	M: 239 F: 79	13.5
Hendershot (2010); Bryan (2012) ^a	Most recent	Used	Used	Youth on probation	Approached in youth probation office waiting room during peak hours	Denver, CO	Both	24.50%	16.71	443	13
Sanders (2010); Dodge (2010) ^b	Most recent	Used at any point	Used	Adults	National probability sample recruited through Knowledge Networks	United States	Both	M: 10.2% F: 11.3%	M: 41.5 F: 39.8	M: 903 F: 792	13.5
Tucker (2010)	Most recent	Consistently used	Hour preceding	Women living in temporary shelters	Stratified random sample	Los Angeles County, CA	Females	40.2%	36.6	445	15
Tucker (2012)	Most recent	Consistently used	Hour preceding	Homeless youth	Stratified random sample	Los Angeles, CA	Both	23.16%	20.4	309	15
Tucker (2013)	Most recent	Consistently used	Hour preceding by either partner	Homeless men	Stratified random sample	Los Angeles, CA	Males	72%	45.6	305	14.5

Notes: M = male; F = female. *N* is the total number of respondents used in the analysis. ^aNumbers in table are from Hendershot et al. (2010); ^bnumbers in table are from Sanders et al. (2010).

Figure 5 presents the results stratified by age. The test for subgroup differences was marginally significant, $\chi^2(1) = 2.78$, $p = .10$. Although the pooled OR was not significant for adults (OR = 0.92, 95% CI [0.64, 1.33]), there was a significant relationship between condom use and marijuana use for adolescents. For the adolescent subset, odds of using a condom were significantly lower for those who used marijuana around the time of intercourse than for those who did not (OR = 0.62, 95% CI [0.47, 0.82]). Neither the adult, $I^2 = 0\%$, $\chi^2(5) = 4.28$, $p = .51$, nor the adolescent, $I^2 = 15\%$, $\chi^2(4) = 4.68$, $p = .32$, subsamples had significant heterogeneity.

The potential influence of statistically adjusting for confounders was examined in the final stratified analysis (Figure 6), which compared estimates that did or did not statistically adjust for confounders (e.g., partner status, alcohol use, at-

titudes toward condoms, emotional distress). Although the effect of marijuana on condom use was not significant when only crude estimates were considered (OR = 0.89, 95% CI [0.59, 1.36]), the effect was significant for adjusted estimates (OR = 0.72, 95% CI [0.57, 0.91]). There was considerable heterogeneity in the crude analysis, $I^2 = 60\%$, $\chi^2(4) = 9.93$, $p = .04$, but not the adjusted analysis, $I^2 = 14\%$, $\chi^2(9) = 10.44$, $p = .32$.

Discussion

This meta-analysis found that use of marijuana at intercourse was associated with lower odds of condom use; confidence in this relationship is strengthened by the fact that significance remained when only estimates adjusted for covariates were included but not when only crude estimates

Figure 2. Funnel plot

Figure 3. Overall forest plot

Figure 4. Forest plot: Males versus females

Figure 5. Forest plot: Adolescents versus adults

Figure 6. Forest plot: Crude versus adjusted

were considered. Although differences by gender were not statistically significant, the trend toward a larger detrimental effect on condom use for females indicates the need for future research that considers the influence of gender. When the analysis was stratified by age, the effect was significant among adolescents but not adults, similar to the results of Leigh (2002).

However, our results differ from some daily diary studies, such as Hensel et al. (2011) and Kerr et al. (2015), who did not find an association between marijuana use and condom use for adolescent females or college students, respectively. The difference between the Hensel et al. (2011) article and the adolescent subgroup analysis presented in this meta-analysis could be attributable to the difference in the populations, as Hensel et al. (2011) recruited participants from a primary care clinic, whereas the adolescent-focused studies in this meta-analysis recruited from high-risk populations. More research is clearly needed before firm conclusions can be drawn, and a meta-analysis synthesizing daily diary studies would be the logical next step, because such studies are able to adjust for between-subject factors that could affect both marijuana use and condom use. However, as the first meta-analysis examining marijuana use and condom use at events of intercourse, our study can help focus interventions related to marijuana use and sex behavior, as well as identify gaps in the literature.

Although this meta-analysis cannot draw conclusions about why marijuana might affect adolescent but not adult condom use, the available literature can give some insights. Previous research with adolescents has found reported self-efficacy for condom use to be lower in the context of marijuana use (Kasen et al., 1992), and marijuana has also been found to affect communication attention and coherence (Weil & Zinberg, 1969). Thus, self-efficacy and communication about condoms and their relation to condom use in adolescents under the influence of marijuana would seem to be a valuable area for further investigation. Another explanation for the results may be found in the study populations. The studies of adolescents sampled youth in detention facilities (Kingree & Betz, 2003; Kingree & Phan, 2002; Kingree et al., 2000) and youth experiencing homelessness (Bailey et al., 1998), who may differ in ways other than age from the members of the general population (Sanders et al., 2010) or adult populations affected by drug use (Leigh et al., 2008; McMahon et al., 2006) or homelessness (Tucker et al., 2010, 2012, 2013) sampled in the studies of adults.

All included studies were of good quality according to a modified version of the Downs and Black quality assessment tool (Table 1). Study variables were well defined, many possible confounders were controlled for, and participant selection methods were clearly described. However, the questions on the Downs and Black quality assessment tool were not

particularly applicable to these types of studies, indicating the need for a quality assessment tool for cross-sectional studies that do not include an intervention.

Limitations

This meta-analysis is limited by the potential for sources of bias. The measures used have the potential for social desirability bias, as respondents may have altered their responses to the questions regarding their use of condoms and marijuana in a way they perceived would please the interviewer. However, authors of the individual studies within this meta-analysis expressed little concern about such bias (Kingree & Betz, 2003; Tucker et al., 2012). Supporting this conclusion, Kingree & Phan (2001) found similar associations between biological and self-report measures of risky sexual behavior and marijuana use.

The nature of the studies themselves created other limitations. Because of the nature of the topic, all of the studies were observational. Although some used a sampling design with some form of random selection (Kingree et al., 2000; Leigh et al., 2008; McMahon et al., 2006; Sanders et al., 2010; Tucker et al., 2010, 2012, 2013), others did not. Also, whereas the single-event methodology has advantages over associations of global measures of condom use and marijuana use, longitudinal investigations such as daily diary studies that allow for within-subject analyses would give a different perspective on the topic. Our analysis is also limited by the composition of the study populations, which were almost all considered high risk (e.g., people experiencing homelessness, sex workers), thereby limiting the generalizability of findings. This limitation also potentially explains the differing results found in the literature, such as Hensel et al. (2011), who studied a general population. More research needs to be conducted among the general population, among both adolescents and adults, to clarify whether sample characteristics are driving these results. The variation in types of covariates included was also a limitation. As psychological covariates such as risk taking have been shown to be associated with both condom use and marijuana use (Schafer et al., 1994), a sub-analysis of only estimates adjusting for these variables was originally planned. However, as only studies of adolescents adjusted for these covariates, such an analysis would have overlapped with the age sub-analysis. Similarly, an analysis by partner status (e.g., casual vs. steady partner) would have been informative, as differences in the impact of marijuana use on condom use by partner type have been found in the literature (Walsh et al., 2014). However, only one study (Bryan et al., 2012) provided data on the relationship between marijuana use and condom use by relationship status. As many studies controlled for partner status in their final adjusted models (Bailey et al., 1998; Dodge et al., 2010; Hendershot et al., 2010; Kingree & Betz, 2003; Sanders et al., 2010; Tucker et al., 2012, 2013), this meta-analysis

does somewhat address this variable. However, as the analysis by Bryan et al. (2012) did demonstrate the potential for a moderating relationship between these two variables, the role of partner status should be examined with future research.

This meta-analysis included only studies published in English and those of a certain design. The inclusion of only English-language studies meant that study populations were more similar to each other (e.g., United States only) than if non-English language studies had also been included. The exclusion of daily diary studies and studies averaging results over several instances of intercourse also allowed for only studies with similar designs to be analyzed—which does permit more specific conclusions to be drawn. Also limiting was the exclusion of several studies that measured both condom use and marijuana use at last intercourse but did not report associations between the variables.

Conclusions

In conclusion, this meta-analysis found that the odds of condom use were lower for those who used marijuana around the time of intercourse than for those who did not, with a sub-analysis by age demonstrating significance only for adolescents. However, the samples studied, particularly the adolescent samples, were not representative of the general population. Future research should focus on general populations, not just those considered high risk. Research on adult populations should also seek to include important psychological confounding variables, which were common in the studies of adolescents. Our results indicate that sexual health interventions for adolescents, especially, should take into account the possibility that marijuana use inhibits condom use.

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