2010

A Meta-analysis of Interventions to Reduce Adolescent Cannabis Use

Kimberly Bender, Stephen Tripodi, Christy Sarteschi, and Michael G. Vaughn

Abstract

Several interventions have been rigorously tested for their ability to reduce adolescent cannabis use; however, this meta-analysis is among the first to synthesize effects across intervention studies. A systemized search of the literature identified 15 random clinical trials and 2 quasi-experimental studies of interventions to reduce adolescent cannabis use. Pooled effects of standardized mean differences (Hedges's *g*) were utilized to synthesize data from these 17 intervention studies. Stratified analyses compared effects for individual verses family-based interventions. Pooled effects indicated interventions to reduce adolescent marijuana use have a moderate effect (Hedges's $g = .544$, $p<.001$). Stratified analyses revealed similarly moderate effects for individual ($g = -0.542$) and family-based treatments ($g = -.557$). Results indicate that existing interventions significantly reduce adolescent cannabis use. Substance abuse treatment programs should be aware of the impact of interventions to specifically address cannabis use and, where risk is identified, implement evidence-based interventions highlighted in this meta-analysis.

Key words: cannabis, marijuana, adolescent, substance abuse, meta-analysis

Introduction

According to the 2008 National Survey on Drug Use and Health, cannabis is the most commonly used illicit drug in the United States, and the vast majority of new cannabis users are adolescents [1]. While rates of cannabis use have been slowly declining since the mid-1990s, in recent years, slow declines in use have leveled off [2]. National estimates indicate 10% of 8th graders have used cannabis in the previous year, and, by 12th grade, rates of use increase to 32% of students [3], suggesting that cannabis use among adolescents remains a serious concern [4].

Cannabis use is associated with physical, mental and social consequences. Physically, smoking cannabis has been related to weakened immune system [5], lung infections, and lung cancer [6,7]. Further, psychomotor effects of smoking cannabis, including impairments to coordination and reaction time [8], put users at increased risk for automobile accidents and related injuries [9,10]. Mentally, cannabis users often demonstrate impaired short-term memory and difficulty shifting attention to new topics and sustaining attention [11-13].

Such effects can be detrimental for adolescents as they develop into young adults. Cannabis use is associated with poor school performance, declining IQ, and reduced likelihood of graduating from high school [14-16]. Socially, cannabis users are more likely to display delinquent and sexual health risk behaviors as adolescents [14], and experience disruptions in their transitions into young adulthood, including unemployment, increased rebelliousness, and increased risk of unmarried pregnancies [17,18].

Considering the serious psychosocial problems associated with cannabis, interventions have been developed and tested for their ability to reduce adolescent cannabis use. Interventions are typically provided directly to the adolescent or to the adolescent in the context of his/her family. Individual interventions generally take one of three approaches. Behavioral approaches

help youth recognize triggers for their cannabis use and develop refusal skills and behavior management techniques to reduce use in the presence of triggers [19,20]. Cognitive-behavioral approaches attempt to identify and change distorted thoughts and maladaptive perceptions that lead to problematic behaviors [21,22]. Finally, motivational approaches encourage clients to acknowledge their substance use and develop internal motivation for changing their behaviors [23]. Rigorous tests of these individual interventions generally demonstrate positive outcomes, including reduced use, abstinence, reduced intentions to use, and reduced association with friends who use cannabis [19,24,25].

Intervention researchers have underscored the importance of treating adolescent substance users in the context of their families [20], asserting that family dynamics and parental support are essential components of treatment [26]. Such multi-system approaches aim to reduce adolescent cannabis use by addressing risk factors, not only in the youths' family, but often in school, peer, and community systems. Several family-based interventions, including Brief Strategic Family Therapy, Multisystemic Therapy, Multidimensional Family Therapy, Parent Coping Skills Training, Functional Family Therapy, and Integrated Family and Cognitive Behavioral Therapy have been tested for their ability to reduce adolescent substance use. Several of these interventions are shown to effectively reduce or eliminate adolescent cannabis consumption during the study period [27-29].

Efforts to synthesize effects across intervention studies are important in order to determine the relationship between treatment and reduction/cessation of cannabis use. While a synthesis of interventions to reduce adolescent cannabis use does not exist, previous research has synthesized related topics, including the effectiveness of preventive interventions for adolescent substance use [30], brief interventions for reducing adolescent substance use [31], controlled

evaluations of adolescent substance abuse treatment [32], and outpatient treatments for adolescent substance abuse [33]. These reviews generally confirm that substance abuse treatment and prevention contribute to the reduction of substance use, although to varying degrees, depending on the type of substance targeted and the intervention provided. They also stress the effectiveness of structured, interactive, skill-building modalities [30,32]. This study aims to add to this literature by conducting a meta-analysis of existing adolescent interventions to determine their ability for specifically reducing cannabis use.

Furthermore, a closer examination of the comparative effects of individual and family-based treatment is necessary. Some researchers argue that family-based interventions neglect intrapersonal risk factors for substance use such as self-efficacy, refusal skills, and personal strategies for coping with urges [22]. In contrast, a previous meta-analysis on drug abuse outcomes among adolescents and adults favors family treatment over individual counseling [34]. Thus, in addition to investigating the effects of interventions to reduce adolescent cannabis use, a second aim of this study is to conduct an updated comparison of the effects of individual treatments versus family-based treatment approaches to reduce cannabis use among adolescents.

Methods

Data Sources and Searches

We followed standardized protocols for the identification, acquisition, coding, and analysis of studies of treatment effects on cannabis use outcomes consistent with the Quality of Reporting of Meta-analyses (QUOROM, [35]). The search objective was to identify all studies that involved a comparison to a focal treatment targeting cannabis use outcomes for adolescent clients for a forty eight-year time span (between 1960 and 2008). This time frame was selected in order to capture all potential studies. Databases systematically searched included: MEDLINE,

PsycINFO, ERIC, Social Science Abstracts, Criminal Justice Abstracts, Social Work Abstracts, Social Science Citation Index, Dissertation Abstracts International, National Criminal Justice Research Service, Social, Psychological, Criminological, Educational Trials Register (C2-SPECTR), and the PsiTri database of randomized and controlled trials in mental health. Numerous alcohol and drug treatment web sites were also searched. Manual searches of the reference sections of identified studies, reference sections of recent pertinent book titles, and government documents were also conducted.

Keyword searches included the following descriptors entered singularly and in Boolean format with "and" or "or": "Adolescent," "Cannabis", "Cannabis", "Cannabis Abuse", "Cannabis Dependence", "Cannabis Dependence", "Drug Abuse,", "Drug Dependence," "Substance Abuse," "Substance Use Disorders," "Psychosocial Interventions," Treatment", "Psychosocial Treatments," "Youth," "Behavioral Interventions," "Behavioral Treatments," "Psychotherapy," "Randomized Controlled Trials," and "Controlled Clinical Trials." If a study appeared promising we retrieved the full text version. Following search descriptor refinements, duplicate citation removal, and step-by-step screening and filtering of articles vis-a-vis inclusion criteria, full text articles were reexamined for relevance and final study selection.

Study Selection

Studies were selected according to the following eligibility criteria established a priori: a) only evaluations of interventions targeting adolescents were included unless studies of mixed groups of adolescents and adults could allow specific determinations as to the effectiveness of treatment outcomes for adolescent subjects, b) investigations utilizing pharmacological therapies were included only if part of an integrated treatment protocol combining medications with one or more psychosocial interventions, c) cannabis use treatment outcomes (as opposed to compliance,

safety, other problem behaviors, or prevention-only outcomes) were examined, d) studies included a quantitative cannabis use outcome measure, e) studies were included if there was a contrast condition for comparison (i.e., comparison group that included a control group, wait-list control or contrasting treatment group as part of the design) published in English. The Quorum flowchart [35] illustrates the study screening process (See Figure 1).

Data Extraction and Quality Assessment

Study characteristics such as citation information, methodological attributes, outcome variable information, measures, key findings, intervention description as well as other pertinent information such as sample size were recorded independently by study authors onto an intervention coding form. Following this initial coding procedure, information was double-coded by a second coder. Two dyads of author's independently coded studies and interrater agreement assessment showed minimal coding error (Kappa > .75). Reitzel and Carbonell [36] suggest that the Kappa statistic is a superior calculation because it adjusts for the proportion of the rater's agreement that could occur between raters due to chance. Study authors met to evaluate any remaining discrepant codes and consensus was achieved via discussion.

Analysis of Methodological Quality

Each study was rated with regard to methodological characteristics using an adapted version of the Methodological Quality Rating Scale (MQRS). This scale was developed by Miller, Brown, Simpson, Handmaker, Bien, Luckie, et al. [37] and the Mesa Grande project evaluating alcohol dependence treatment outcome studies [38] and has been used in other systematic reviews [32,39] and meta-analyses [40]. Each study was evaluated across 13 methodological attributes. The maximum number of points a study could garner range from 1 (extremely poor quality) to 16 (exceptionally high quality).

Data Synthesis and Analysis

We combined data from multiple intervention studies targeting cannabis use outcomes. Cannabis use outcomes were measured as reductions in the frequency of cannabis use (i.e., use days, how often used) assessed by structured interviews and substantiated by collateral information. We used the software Comprehensive Meta-Analysis 2.0 [41]. For intervention studies with sufficient statistical information, this program calculates the standardized mean difference effect size. We used Hedges's adjusted *g* for effect sizes to correct for sample size bias [42,43]. For treatment/comparison design studies, the effect size was calculated as the difference between the intervention group's mean posttest score and the comparison group's mean posttest score divided by the pooled standard deviation and adjusted for sample size. We examined and corrected extreme values using winsorizing techniques [44]. This process results in identifying extreme effects (> than two standard deviations from the mean) and assigning these effects a value equivalent to two standard deviations. Due to dispersion based on clinical inference and supported by statistically significant Q-value and relatively high tau-squared and I-squared values, we could not assume the true effect was identical across studies, and subsequently used a random-effects model over a fixed effects model to estimate pooled effects. The random effects model takes into account sources of variation within and between studies [45]. Fixed effects often inflate effect size precision due to narrower confidence intervals compared to random effects models [46]. As such, random effects models provide a more conservative estimate. We also tested pooled effects using a mixed effects model which did not assume common variance among studies across subgroups but combined subgroups using a fixed effect [47]. Heterogeneity was explored using stratified analyses. Funnel plots and associated statistics were examined to evaluate publication bias. A fail-safe N was computed in order to

assess the file drawer problem inherent in meta-analyses (i.e., how many studies with null or differential effect is necessary to invalidate study results).

Results

Search Results

Figure 1 illustrates the study screening process. Potentially relevant studies yielded a total of 72 titles and abstracts. If a study appeared promising we retrieved the full text version. Following search descriptor refinements, duplicate citation removal, and step-by-step screening and filtering of articles vis-a-vis inclusion criteria, 31 publications remained. Full text articles were reexamined for relevance and final study selection. Findings from 17 investigations published between 1985 and 2008 constituted the final study sample.

Study Characteristics

As shown in Table 1, all 17 of the studies contained in this analysis were journal article publications. Approximately 40 percent were recent, published between 2005 and 2008. Only one article was published in the 1980's. The entire sample of youth participants within this meta-analysis was within the age range of 12-19 and all studies were carried out within the United States. A majority (64.7%) of the studies tested individual-based therapies and approximately one third tested family therapies. With regard to study design, 15 (94%) utilized experimental designs. Only two studies were quasi-experimental. Nearly all of the studies were conducted at single site locations, were considered replicable and reported baseline participant characteristics. Almost 100 percent of all of the studies reported that their interventions were standardized by a manual or required the specific training of research staff. The majority of studies reported utilizing objective verification when collecting data and reported utilizing collateral verification. The majority (52.9%) of studies had a follow-up length of between 6-11 months. Less than half

(41.2%) had follow-up length periods of less than six months and 23.5 percent reported following up with study participants one year or later. Assessment of follow-up time periods revealed that 47% of the studies were able to garner 85-100% of their original study participants. The majority of studies enumerated study dropouts.

Overall Comparisons of Treatment Effects

As shown in Table 2, the overall pooled random effects size was (Hedges's g = -0.54, 95% CI = -0.72 – -0.37). The range of standardized effects for reducing cannabis use was substantial ranging from non-significant -0.06 (95% CI = -0.47 – 0.36) for Multidimensional Family Therapy vs. Cognitive Behavioral Therapy [28] to -1.99 (95% CI = -2.34 – -1.64) for Teaching Family– an intervention targeting youth and their group home parents vs. usual care [48]. All tested interventions yielded reductions in cannabis use. Several other tested treatments yielded large effects (> 0.80), including Behavioral Treatment vs. supportive counseling (Hedges's g = -1.06, 95% CI = -1.74 – -0.37) [19], Integrated Family Cognitive Behavioral Therapy vs. psychoeducation (Hedges's g = - 0.94, 95% CI = -1.57 – -0.31) [27], Multidimensional Family Therapy vs. family education (Hedges's g = -0.81, 95% CI = -1.28 – -0.34) [49], Motivational Interviewing vs. inpatient therapy (Hedges's g = -1.58, 95% CI = -1.94 – -1.22) [50], and Cognitive Behavioral Therapy vs. Functional Family Therapy (Hedges's g = -0.86, 95% CI = -1.38 – - 0.34) [22]. As expected, treatments effects tended to lose effectiveness over time. Although the preponderance of studies did not include long-term assessments (i.e., 12 months or greater), those studies that did revealed that Behavioral Treatment and Multidimensional Family Therapy possessed large enduring effects.

Stratified and Sensitivity Analyses

Stratified analyses by individual vs. family intervention classifications showed that pooled effects revealed slightly larger effects for family-based interventions (Hedges's *g* = -.557, 95% CI = -.933 – -.181) compared to individual interventions (Hedges's *g* = -.512, 95% CI = -.800 – -.285). Moreover, as expected, pooled effects revealed larger effect sizes for outcomes with follow-up data of six months or less (Hedges's *g* = -.501, 95% CI = -.700 – -.303) compared to follow-up data of greater than six months (Hedges's *g* = -.375, 95% CI = -.616 – -.134). We used Duval and Tweedie's trim and fill method [51] to examine and impute studies based on any asymmetric pattern and results showed a small change in overall pooled effects based on imputation of eight studies (decrease in cannabis use of - 0.13 in Hedges's g) suggesting that publication bias is minimal. A fail safe N was also computed to address the file drawer problem and results showed that 1296 outcome studies with null findings would be necessary to change the alpha to a non-significant value (p>.05). Although relatively low in power, Egger's regression intercept was non-significant, also suggesting lack of publication bias.

Discussion

This meta-analysis finds several treatments to be associated with a reduction in cannabis use among adolescents. Synthesis across 17 studies with 31 outcomes revealed an overall Hedges's *g* pooled effect size of .544 (p<.001). Thus, interventions to reduce adolescent cannabis use appear to have a medium effect, according to Cohen's heuristics (<.20 = small, .50 = moderate, >.80 = large) [52].

Intervention approaches varied in their impact on cannabis use reduction, ranging from small to large effects. Interventions with large effect sizes (>.80) included several family-based or multi-system approaches (Integrated Family and Cognitive Behavior Therapy, Multidimensional Family Therapy, and Teaching Family). A recent meta-analysis synthesizing

studies of outpatient interventions [33], similarly highlights both Cognitive Behavioral group treatment and Multidimensional Family Therapy as well established treatments for reducing adolescent substance abuse more broadly. Considering large effects sizes across these approaches, efforts to engage family, school, peer, and other service providers in adolescent treatment appears promising in reducing adolescents' cannabis use.

Several individual treatment approaches also demonstrated large effects. Motivational Interviewing (MI) was highlighted for having a large impact on reducing cannabis use. Large effects reported across motivational interviewing trials [24,50] underscore the importance of motivation enhancing approaches to reducing adolescent substance use. Although motivational interviewing has been shown to reduce adolescent substance use previously [31], the effects of this intervention with cannabis users requires further investigation as other tests of MI report small to moderate effects [53,54]. Behavioral Treatment and Cognitive Behavioral Treatment (CBT) approaches also demonstrated large effects, although findings for CBT were inconsistent with small to moderate effect sizes associated with some outcomes.

An aim of this meta-analysis was to compare the effects of family-based verses individual treatment modalities in reducing adolescent cannabis use. Stratified analyses revealed similarly moderate effects for individual (g = -0.54) and family-based (g = -0.56) approaches to treatment. This finding is in contrast to previous work that identifies family-based interventions as better at retaining clients and, therefore, more effective than individual or peer group treatment at reducing substance use [34,55]. The current study, however, finds both types of treatment to be statistically significant (p<.001) and many of the specific interventions for both modalities to contain large effect sizes. These findings suggest that, when addressing cannabis use, individual and family-based interventions may both be moderately effective.

Not surprisingly, studies with longer periods of follow up demonstrated smaller effect sizes. Greater opportunity for cannabis use and reduced use of behavioral or cognitive skills over time make the period between the end of the treatment and follow-up data collection an important factor to consider in synthesizing substance use outcomes. Despite decreases in effect sizes over time, several interventions maintained significant reductions in cannabis use at 12 months post treatment: Behavioral Treatment, Teaching Family, and Multidimensional Family Treatment.

Certain limitations should be considered when interpreting these results. Inclusion criteria were purposely narrow in an attempt to reduce heterogeneity among studies; however, specific cannabis use outcomes did differ slightly, increasing the chances of construct validity invariance [56]. Outcomes examined included: Cannabis use, cannabis use frequency, days of cannabis use, quantity of cannabis use, and past month cannabis use. While similar, results would be considered more valid if the outcomes were identical. Furthermore, studies synthesized in this meta-analysis included both those that compared one active treatment to another active treatment (e.g., CBT vs. MDFT) as well as studies that compared an active treatment to a waitlist control group or services as usual. Effect sizes are expected to be smaller for studies comparing two active treatments as "control" groups are likely to improve in cannabis outcomes. The limited number of available trials aimed at reducing marijuana use limited our ability to investigate this factor, but comparisons of effect size magnitude across studies should be done cautiously and include consideration of this methodological difference. In addition, overall effect sizes reported in this study represent a synthesis of different follow-up periods. Stratified analyses were conducted in an attempt to address this concern. Finally, we were not able to stratify results based on treatment setting and intensity (weekly outpatient, intensive outpatient, group home-

based treatment, or school-based treatment). As more clinical trials to reduce cannabis use are conducted, future meta-analyses should whether type of treatment setting is an important factor affecting outcomes.

This meta-analysis represents the first known synthesis of interventions aimed at reducing adolescent cannabis use. Yet, interventions targeting cannabis are rare and have only recently been tested [4]. As the number of rigorously designed cannabis intervention studies increases, future meta-analyses should aim to identify specific interventions and associated moderating variables that serve to reduce adolescent cannabis use. Furthermore, cannabis researchers advocate for investigating cost-effective interventions, suggesting that brief interventions targeting motivation and cognition offering promising treatment effects at reduced costs [57]. Such future efforts will guide development of substance abuse treatment programs that include effective replicable treatment elements, thereby reducing use of a substance with known psychosocial risks to adolescents.

References

1. SAMHSA (Substance Abuse and Mental Health Services Administration). Office of Applied Studies. Rockville (MD). Results from the 2007 National Survey on Drug Use and Health: National Findings. 2008. NSDUH Series H-34, DHHS Publication No. SMA 08-4343.

2. National Institute of Health. Downward trend in teen marijuana use slows; prescription drug abuse remains high: NIDA's 2008 Monitoring the Future Survey shows mixed results. Washington DC: U.S. Department of Health and Human Services; 2008.

3. Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE; National Institute on Drug Abuse. Bethesda (MD). Monitoring the Future national results on adolescents drug use: Overview of key finding, 2007. 2008. NIH Publication No. 08-6418.

4. Volkow ND Marijuana abuse: National Institute on Drug Abuse Research Report Series. 2005. NIH Publication Number 05-3859.

5. Adams IB, Martin BR. Cannabis: Pharmacology and toxicology in animals and humans. Addiction 1996; 91: 1585-1614.

6. Benson M, Bentley AM. Lung disease induced by drug addiction. *Thorax* 1995; 50: 1125-1127.

7. Tashkin DP. Pulmonary complications of smoked substance abuse. *West J Med* 1990; 152: 525-530.

8. Hall W, Degenhardt L, Lynskey M. The Health and Psychological Effects of Cannabis Use. Monograph Series no. 44. Sydney: National Drug and Alcohol Research Centre, University of New South Wales; 2001.

9. Blows S, Ivers RQ, Connor J, Ameratunga S, Woodward M, Norton R. Marijuana use and car crash injury. *Addiction* 2005; 100: 605-611.

10. Lang SW, Waller PF, Shope JT. Adolescent driving: Characteristics associate with single-vehicle and injury crashes. *J Safety Res* 1996; 27: 341-257.

11. Ashton CH. Pharmacology and effects of cannabis: A brief review. ***Br J Psychiatry*** 2001; 178: 101-106.

12. Heishman SJ, Arasteh K, Stitzer ML. Comparative effects of alcohol and marijuana on mood, memory, and performance. *Pharmacol Biochem Behav* 1997; 58: 93-101.

13. Pope HG, Yurgelun-Todd D. The residual cognitive effects of heavy marijuana use in college students. *JAMA* 1996; 275: 521-527.

14. Brook JS, Balka EB, Whiteman M. The risks for late adolescence of early adolescent marijuana use. *Am J Public Health* 1999; 89: 1549-1554.

15. Fried P, Watkinson B, James D, Gray R. Current and former marijuana use: Preliminary finding of a longitudinal study of effects on IQ in young adults. *Can Med Assoc J* 2002; 166: 887-891.

16. Lynskey M, Hall W. The effects of adolescent cannabis use on educational attainment: A review. *Addiction* 2000; 95: 1621-1630.

17. Brook JS, Adams RE, Balka EB, Johnson E. Early adolescent marijuana use: Risks for the transition to young adulthood. *Psychol Med* 2002; 32: 79-91.

18. Brook JS, Richter L, Whiteman, Cohen P. Consequences of adolescent marijuana use: incompatibility with the assumption of adult roles. *Genet Soc Gen Psychol Monogr* 1999; 125: 193-207.

19. *Azrin NH, McMahon PT, Donohue B, Besalel VA, Lapinski KJ, Kogan ES, et al. Behavior therapy for drug abuse: A controlled treatment outcome study. *Behav Res Ther* 1994; 33: 857-866.

20. Thatcher DL, Clark DB. Adolescent alcohol abuse and dependence: Development, diagnosis, treatment and outcomes. *Curr Psychiatry Rev* 2006; 2: 159-177.

21. Kaminer Y, Burleson JA, Blitz C, Sussman J, Rounsaville BJ. Psychotherapies for adolescent substance abusers: A pilot study. *J Nerv Ment Dis* 1998; 186: 684-690.

22. *Waldron HB, Slesnick N, Brody JL, Turner CW, Peterson TR. Treatment outcomes for adolescent substance abuse at 4- and 7- month assessments. *J Consult Clin Psychol* 2001; 69: 802-813.

23. Tevyaw TO, Monti PM. Motivational enhancement and other brief interventions for adolescent substance abuse: Foundations, applications and evaluations. *Addiction* 2004; 99: 63-75.

24. *D'Amico EJ, Miles JV, Stern SA, Meredith LS. Brief Motivational Interviewing for Teens at Risk of Substance Use Consequences: A Randomized Pilot Study in a Primary Care Clinic. *J Subst Abuse Treat* 2008; 35: 53-61.

25. *Godley MD, Godley SH, Dennis ML, Funk R, Passetti LL. The effect of assertive continuing care on continuing care linkage, adherence and abstinence following residential treatment for adolescents with substance use disorders. *Addiction* 2006; 102: 81-93.

26. Bukstein O, Dunne FE, Ayers W, Arnold V, Benedek E, Benson RS, et al. Practice parameters for the assessment and treatment of children and adolescents with substance use disorders. *J Am Acad Child Adolesc Psychiatry* 1997; 36: 140-157.

27. *Latimer WW, Winters KC, D'Zurilla T, Nichols M. Integrated Family and Cognitive-Behavioral Therapy for adolescent substance abusers: A Stage I efficacy study. *Drug Alcohol Depend* 2003; 71: 303-317.

28. *Liddle HA, Dakof GA, Turner RM, Henderson CE, Greenbaum PE. Treating Adolescent Drug Abuse: A Randomized Trial Comparing Multidimensional Family Therapy and Cognitive Behavior. *Addiction* 2008; 103: 1660-1670.

29. *McGillicuddy NB, Rychtarik RG, Duquette JA, Morsheimer ET. Development of a Skill Training Program for Parents of Substance-Abusing Adolescents. *J Subst Abuse Treat* 2001; 20: 59-68.

30. Tobler NS, Roona MR, Ochshorn P, Marshall DG, Streke AV, Stackpole KM. School-based adolescent drug prevention programs: 1998 meta-analysis. *J Prim Prev* 2000; 20: 275-336.

31. Tait RJ, Hulse GK. A systematic review of the effectiveness of brief interventions with substance using adolescents. *Drug Alcohol Rev* 2003; 22: 337-347.

32. Vaughn MG, Howard MO. Adolescent substance abuse treatment: A synthesis of controlled evaluations. *Res Soc Work Pract* 2004; 14: 325-335.

33. Waldron HB, Turner, CW. Evidence-based psychosocial treatments for adolescent substance abuse. *J Adolesc Health* 2008; 37: 238-261.

34. Stanton MD, Shadish WR. Outcome, attrition, and family-couples treatment for drug abuse: A meta-analysis and review of the controlled comparative studies. *Psychol Bull* 1997; 122:170-191.

35. Moher D, Cook DJ, Eastwood S, Olkin I, Drummond R, Stroup DF. (1999). Improving the quality of reports of meta-analyses of randomized controlled trials: the QUOROM statement. *The Lancet* 1999; 354: 1896-1900.

36. Reitzel LR, Carbonell JL. The effectiveness of sexual offender treatment for juveniles as measured by recidivism: A meta-analysis. *Sex Abuse* 2006; 18: 401-421.

37. Miller WR, Brown JM, Simpson TL, Handmaker NS, Bien TH, Luckie LH, et al. What works? A methodological analysis of the alcohol treatment outcome literature. In: Hester RK, Miller WR, editors. Handbook of alcoholism treatment approaches: Effective alternatives. 2nd ed. Needham Heights (MA): Allyn and Bacon; 1995. p. 12-44.

38. Miller WR, Wilbourne PL. Mesa grande: A methodological analysis of clinical trials of treatment for alcohol use disorders. *Addiction* 2002; 97: 265-277.

39. Vaughn MG, Howard MO. Integrated psychosocial and opioid antagonist treatment for alcohol dependence: A systematic review of controlled evaluations. *Soc Work Res* 2004; 28: 41-53.

40. Apodaca TR, Miller WR. A meta-analysis of the effectiveness of bibliotherapy for alcohol problems. *J Clin Psychol 2003; 59:* 289-304.

41. Borenstein M, Hedges L, Higgins J, Rothstein H. Comprehensive Meta Analysis, Version 2. Englewood (NJ): Biostat; 2005.

42. Deeks JJ, Altman DG, Bradbrun MJ. Statistical methods for examining heterogeneity and combining results from several studies in meta-analysis. In: Egger M, Davey Smith G, Altman DG, editors. Systematic reviews in health care: meta-analysis in context. London (United Kingdom): BMJ Publishing Group; 2001. p. 285–312.

43. Rosenthal R. Parametric measures of effect size. In: Cooper H, Hedges LV, editors. The Handbook of Research Synthesis. New York: Russell Sage Foundation; 1994. p. 231-244.

44. Lipsey MW, Wilson DB. Practical meta-analysis. Thousand Oaks (CA): Russell Sage Foundation; 2000.

45. Borenstein M, Hedges L, Rothstein H. Meta-analysis: fixed versus random effects [Online]. 2007 [cited 2009 Jan 30]; Available from: URL:www.Meta-Analysis.com.

46. Hunter JE, Schmidt FL. Fixed effects vs. random effects meta-analysis models: Implications for cumulative research knowledge. *International J of Select Assess* 2000; 8: 275-292.

47. Review Manager (RevMan) [computer program]. Version 5.0. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration; 2008.

48. *Braukmann CJ, Bedlington MM, Belden BD, Braukmann PD, Husted JJ, Ramp KK, et al. Effects of community-based group-home treatment programs on male juvenile offenders use and abuse of drugs and alcohol. *Am J Drug Alcohol Abuse* 1985; 11: 249-278.

49. *Liddle HA, Dakof GA, Parker K, Diamond GS, Barrett K, Tejeda M. Mulitdeminsional Family Therapy for Adolescent Drug Abuse: Results of a Randomized Clinical Trial. *Am J Drug Alcohol Abuse* 2001; 27: 651-688.

50. *Tomlinson K, Brown SA, Abrantes A. Psychiatric Comorbidity and Substance Use Treatment Outcomes of Adolescents. *Psychol Addict Behav* 2004; 18: 160-169.

51. Duval SJ, Tweedie RL. Trim and fill: A simple funnel plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics* 2000; 56: 455-463.

52. Cohen J. *Statistical power for the behavioral sciences.* 2nd ed. Hillsdale (NJ): Lawrence Erlbaum; 1988.

53. *Baer JS, Garrett SB, Beadnell B, Wells EA, Peterson P. Brief Motivational Intervention with Homeless Adolescents: Evaluating Effects on Substance Use and Service Utilization. *Psychol Addict Behav* 2007; 21 :582-586.

54. *Martin G, Copeland J. The adolescent cannabis check-up: Randomized trial of a brief intervention for young cannabis users. *J Subst Abuse Treat* 2008; 34: 407-414.

55. Winters KC, Leitten W. Brief Intervention for Drug-Abusing Adolescents in a School Setting. *Psychol Addict Behav* 2007; 21: 249-254.

56. Nugent WR. Construct validity invariance and discrepancies in meta-analytic effect sizes based on different measures: A simulation study. *Educ Psychol Meas* 2009; 69: 62-78.

57. Dennis M, Godley SH, Diamond G, Tims FM, Babor T, Donaldson J, et al. The Cannabis Youth Treatment (CYT) Study: Main findings from two randomized trials. *J Subst Abuse Treat* 2004; 27: 197-213.

58. *Godley MD, Godley SH, Dennis ML, Funk R, Passetti LL. Preliminary Outcomes from the Assertive Continuing Care Experiment for Adolescents Discharged from Residential Treatment. *J Subst Abuse Treat* 2002; 23: 21-32.

59. *Henggeler SW, Pickrel SG, Brondino MJ. Multsystemic treatment of substance-abusing and dependent delinquents: Outcomes, treatment fidelity, and transportability. *Ment Health Serv Res* 1999; 1: 171-184.

60. *Liddle HA, Rowe CL, Dakof GA, Ungaro RA, Henderson CE. Early intervention for adolescent substance abuse: Pretreatment to posttreatment outcomes of a randomized clinical trial comparing multidimensional family therapy and peer group treatment. *J Psychoactive Drugs* 2004; 36: 49-63.

61. *Santisteban DA, Perez-Vidal A, Coatsworth DJ, Kurtines DM, Schwartz SJ, LaPerriere A, et al. Efficacy of Brief Strategic Family Therapy in Modifying Hispanic Adolescent Behavior Problems and Substance Use. *J Fam Psychol* 2006; 17: 121-133.

62. *Walker DD, Roffman RA, Stephens RS, Berghuis J, Kim W. Motivational enhancement therapy for adolescent cannabis users: A preliminary randomized controlled trial. *J Consult Clin Psychol* 2006; 74: 628-632.

* Study included in meta-analysis

Figure 1. Study Screening Process Diagram

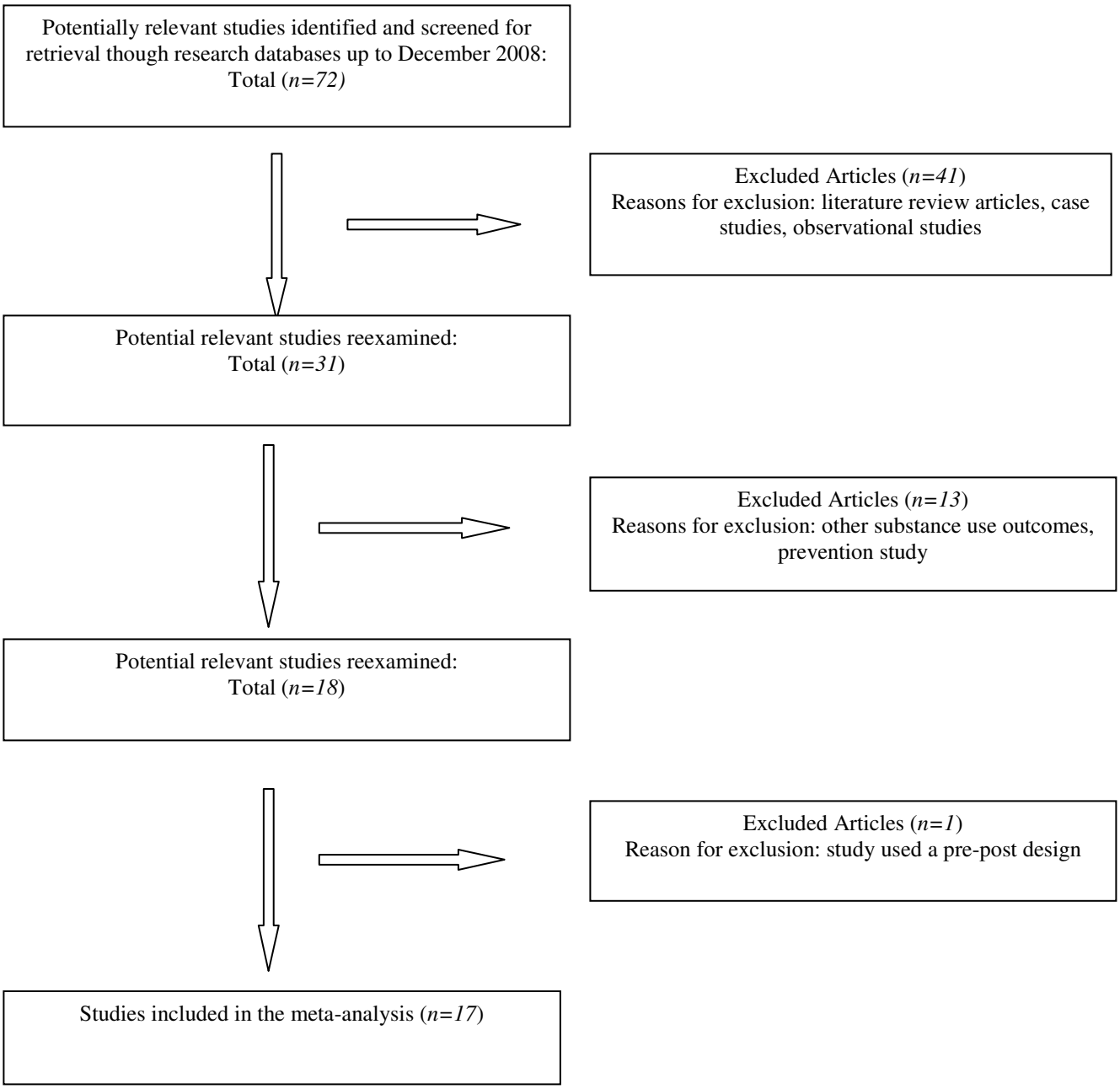

Table 1. Characteristics of Studies Included in Meta-Analysis (N = 17).

Characteristic	*Frequency (%)*
Publication type	
Journal article	17 (100.0)
Publication year	
2007-2008	4 (23.5)
2005-2006	3 (17.6)
2003-2004	3 (17.6)
2001-2002	4 (23.5)
1999-2000	1 (5.8)
Before 1999	2 (11.8)
U.S. samples	17 (100.0)
Intervention tested	
Family	5 (29.4)
Individual	11 (64.7)
Both	1 (5.9)
Age range	
12-19	17 (100.0)
Methodological Attributes	
Considered replicable	16 (94.1)
Reported baseline characteristics	16 (94.1)
Quality control	15 (88.2)
Outcome Follow-up length	
Less than 6 months	7 (41.2)
6 to 11 months	9 (52.9)
12 months or longer	4 (23.5)
Follow-up rate	
Less than 70% completion	2 (11.8)
70 to 84.9% completion	6 (35.3)
85-100% completion	8 (47.0)
Not reported	1 (5.9)
Collateral verification	10 (58.8)
Objective verification	11 (64.7)
Dropouts enumerated	14 (82.3)
Attrition delineated	14 (82.3)
Single site	15 (88.2)
Study Design	
Experimental	15 (88.2)
Quasi-experimental	2 (11.8)

Table 2. Standardized Effects of Intervention Studies Targeting Cannabis Use (N = 17).

Study Name	Comparison	Sample Tx	Sample Comp	Hedges's g	Lower Limit	Upper Limit	Z-Value	p-value
1. Azrin et al. (1994) [19]	BT * vs. SC (12 mo)	81	81	-1.058	-1.742	-0.374	-3.033	0.002
2. Baer et al. (2007) [53]	BMI* vs. TAU (1 mo)	66	51	-0.193	-0.557	0.171	-1.040	0.298
	BMI* vs. TAU (3 mo)	85	51	-0.268	-0.633	0.097	-1.441	0.150
3. Braukmann et al.(1985) [48]	TF** vs. TAU (12 mo)	82	103	-1.991	-2.344	-1.638	-11.056	0.000
4. D'Amico et al. (2008) [24]	BMI* vs. TAU (6 mo)	110	85	-0.775	-1.756	0.205	-1.549	0.121
5. Godley et al. (2002) [58]	ACC* vs. TAU (3 mo)	98	51	-0.427	-1.674	0.819	-0.672	0.502
6. Godley et al. (2006) [25]	ACC* vs. TAU (3 mo)	98	78	-0.289	-0.725	0.148	-1.297	0.195
	ACC *vs. TAU (9 mo)	54	78	-0.319	-0.755	0.118	-1.431	0.152
7. Henggeler et al. (1999) [59]	MST** vs. TAU (130 days)	54	54	-0.337	-0.714	0.041	-1.749	0.080
	MST** vs. TAU (10mo)	58	56	-0.390	-0.758	-0.022	-2.074	0.038
8. Latimer et al. (2003) [27]	IF-CBT* vs. PC (6 mo)	38	21	-0.940	-1.567	-0.314	-2.941	0.003
9. Liddle et al. (2001) [49]	MDFT **vs. FE (6 mo)	38	35	-0.442	-0.902	0.018	-1.885	0.059
	MDFT** vs. FE (12 mo)	38	35	-0.814	-1.287	-0.341	-3.371	0.001
	MDFT** vs. GT (6 mo)	38	28	-0.592	-1.085	-0.099	-2.353	0.019
	MDFT** vs. GT (12 mo)	39	28	-0.565	-1.057	-0.073	-2.250	0.024
10. Liddle et al. (2004) [60]	MDFT** vs. PGT (3 mo)	36	40	-0.605	-1.061	-0.149	-2.600	0.009

	MDFT** vs. PGT (6 wks)	36	40	-0.605	-1.061	-0.149	-2.600	0.009
11. Liddle et al. (2008) [28]	MDFT** vs. CBT (3 mo)	47	49	-0.253	-0.644	0.138	-1.266	0.205
	MDFT** vs. CBT (6 mo)	45	53	-0.089	-0.474	0.296	-0.453	0.650
	MDFT** vs. CBT (12 mo)	38	35	-0.058	-0.475	0.359	-0.273	0.785
12. Martin & Copeland (2008) [54]	BMET* vs. DT (3 mo)	27	27	-0.546	-1.165	0.073	-1.729	0.084
13. McGillicuddy et al. (2001) [29]	PCST** vs. DT (50 days)	14	8	-0.303	-1.144	0.537	-0.707	0.480
14. Santisteban et al. (2006) [61]	BSFT** vs. GT (5 mo)	70	85	-0.380	-0.657	-0.104	-2.694	0.007
15. Tomlinson et al. (2004) [50]	MI* vs. IT (6 mo)	70	88	-1.579	-1.936	-1.221	-8.653	0.000
16. Waldron et al. (2001) [22]	CBT* vs. FFT (4 mo)	31	30	-0.859	-1.378	-0.341	-3.248	0.001
	CBT* vs. FFT (7 mo)	31	30	-0.350	-0.849	0.150	-1.373	0.170
	CBT* vs. GT (4 mo)	31	30	-0.272	-0.770	0.225	-1.072	0.284
	CBT* vs. GT (7 mo)	31	30	-0.594	-1.100	-0.087	-2.296	0.022
	FFT** vs. GT (4 mo)	30	30	-0.616	-1.128	-0.105	-2.361	0.018
	FFT** vs. GT (7 mo)	30	30	-0.235	-0.737	0.266	-0.920	0.358
17. Walker & Roffman (2006) [62]	BMET * vs. DT (3 mo)	47	46	-0.207	-0.611	0.197	-1.003	0.316
Random Effects: Overall				-0.544	-0.719	-0.369	-6.090	<.0001
Random Effects: Family only				-0.557	-0.933	-0.181	-2.905	0.004
Random Effects: Individual only				-0.542	-0.800	-0.285	-4.126	<.0001
Random Effects: Outcomes for greater than 6 month follow-up[1]				-0.375	-0.616	-0.134	-3.051	0.002

Random Effects: Outcomes for 6 month or less follow-up				-0.501	-0.700	-0.303	-4.947	<.0001

Note: * denotes intervention focus on the individual ** denote intervention focus is on the family, citation referenced in [], AA = Active aftercare, ACC = Assertive continuing care, BI-A = Brief intervention with adolescent only, BI-AP = Brief Intervention with adolescent and 1 parent only, BMET = Brief Motivational Enhancement Therapy, BMI = Brief motivational interviewing, BRT = Basic residential treatment, BSFT = Brief strategic family therapy, BT = Behavioral treatment, CBT = Cognitive behavioral therapy, CON = assessment-only Control Condition,DT = Delayed Treatment, FE = Family education, FFT=Functional Family Therapy, GT = group treatment/therapy, IF-CBT = Integrated Family and Cognitive Behavioral Therapy, IT = inpatient therapy, MFT = Multidimensional family therapy, MI = Motivational interviewing, MST = Multisystemic therapy, PC = Psychoeducation curriculum, PCST = Parent coping skills training, PGT = Peer Group Treatment, SC = Supportive counseling, TAU = Treatment as usual, TF = Teach Family (group home parents), TMSL = Triple modality social learning.
[1]Braukmann et al. (1985) removed from random effects models involving time point comparisons.