Addiction SSA SOCIETY FOR THE STUDY OF ADDICTION

Effectiveness of motivational interviewing for adolescents with illicit drug use: Systematic review and meta-analysis

Journal:	*Addiction*
Manuscript ID:	Draft
Manuscript Type:	Review
Date Submitted by the Author:	n/a
Complete List of Authors:	Li, Lili; The University of Hong Kong , Social Work and Social Administration Zhu, Shimin; The University of Hong Kong , Social Work and Social Administration Tse, Nick; The University of Hong Kong , Social Work and Social Administration Tse, Samson; The University of Hong Kong, Social Work and Social Administration Wong, Paul; The University of Hong Kong, Social Work and Social Administration
SUBSTANCE:	drugs general
METHOD:	Review
FIELD OF STUDY:	psychology
Keywords:	Addiction disorder, Psychotherapy, Substance use, Young people

Effectiveness of motivational interviewing for adolescents with illicit drug use: A systematic review and meta-analysis

HIGHLIGHTS

- Effectiveness of MI for decreasing adolescents' illicit drug use was assessed via meta-analysis.
- Among the primary outcomes, MI performed better at changing attitudes than changing behavior.
- The variations in the characteristics of studies were evaluated.
- MI is not as effective for adolescents as the general population.
- Overall, MI has the potential to be efficacious for adolescents with illicit drug use.

ABSTRACT

Purpose: Evidence supporting the use of motivational interviewing (MI) with adolescents is just emerging. Thus, a meta-analysis of MI specifically targeting adolescents with illicit drug use is needed to consolidate the existing evidence. ***Objective:*** This meta-analysis evaluated the efficacy of MI for adolescents with illicit drug use and the relationship between intervention variations and MI treatment outcomes. ***Method:*** EBSCOhost, ProQuest, and Digital Dissertation Consortium were searched with key words. Ten studies representing 1,466 participants were identified and analyzed. ***Results:*** Omnibus effect sizes for all included studies revealed a small, but significant post-intervention effect (d = 0.12, 95% CI [0.02, 0.22], P = 0.02). ***Conclusions:*** The results support the effectiveness of MI interventions for adolescent illicit drug use behavior change. However, MI is not as effective for adolescents as the general population. More studies on moderator effects of specific characteristics of adolescents are warranted.

Keywords: Addiction disorder, psychotherapy, substance use, young people

1. Introduction

Illicit drug use has become increasingly prevalent among adolescents in the past few decades (1). The actual causes of adolescent drug use are multi-factorial and include biological and neurological (2-4), psychological (2, 5, 6), familial (7), and socio-cultural influences (8, 9). One of the biggest challenges to preventing and intervening in illicit drug use, especially among young people, is that many people with substance problems are not motivated to participate in prevention programs (10) and other services (11)

because they are reluctant to recognize that their drug use is problematic (12).

Motivational interviewing (MI) is an emerging treatment for substance abuse that focuses on resolving ambivalence about changes in behaviors. MI is designed to strengthen personal motivation for and commitment to a specific goal by eliciting and exploring the person's own motives for change within an atmosphere of acceptance and compassion (13). MI was originally designed to help adults with drinking problems (14) and has been widely applied in the fields of counseling and psychotherapy for behavioral health problems (15).

Existing reviews and meta-analyses of MI found that MI has been used for various problems, ranging from excessive drinking (16), smoking cessation (17), multiple substance use (18, 19), to health-related behaviors, such as HIV risk behaviors, diet and exercise, and eating disorders (20, 21). Compared to weaker comparison groups (waitlist or no treatment), MI produced greater effects (20, 21); however, MI has not been found to be superior to other active treatments, such as cognitive-behavioral therapy (CBT) and 12-step programs (20-22). When MI has been used to supplement other programs, studies have found a stable effect size (22), and integrating MI with other treatments—such as in addition to CBT—has proven to be fruitful (23). Interestingly, “treatment as usual” (TAU) and “being assessed and receiving feedback” were found to be as effective as MI (19).

Advocates of MI as a brief counseling technique suggested that MI is especially useful for young people (18, 24-26). First, MI is particularly attractive to young people because it is non-confrontational, facilitative, and does not seek to impose specific outcomes (27, 28). Second, ambivalence is common during adolescence, so normalizing both the resistance and desire to change may reduce frustration in both the youth and the

clinician (29). Third, because they are trying out their new roles in this transition period, adolescents prefer to engage with someone who can work with them as a partner and respect their need to explore and establish personal values and goals (30). Also, MI is brief, usually consisting of just one or two sessions. This makes it a promising treatment for adolescents with substance abuse problems because most of them drop out early from standard treatment systems (28). Nevertheless, the evidence supporting the use of MI with adolescents has only just emerged.

A review of the literature that included 39 studies gave summaries of the most up-to-date MI interventions with adolescent substance use (31). That study found that 67% of interventions reported statistically significant improved substance-use outcomes. A meta-analysis by Jensen and colleagues (18) provided evidence that MI has a sustainable effect for adolescent substance-use behavior change. That study reported that the post-treatment effect size for all identified MI interventions was small, but significant (d = 0.17). Although there is some positive evidence for the use of MI with adolescents, no systematic reviews or meta-analyses have been conducted only focusing on the efficacy of MI for adolescents with illicit drug use. Because illicit drug use is very different from other substance use, a meta-analysis specific to MI as a treatment for adolescent illicit drug use is needed to provide the totality of the evidence in the literature and advance the field.

The objective of this study is to fill the research gaps and provide a meta-analysis to examine the effectiveness of MI for illicit drug use among adolescents. To provide an in-depth comparison, this study considers primary outcomes not only of behavior change,

but also attitude change. A secondary objective is to assess the sustainability of the effect of MI over time, across delivery settings, and across study designs.

2. Method

2.1 Data sources and literature searches

We searched the following databases for eligible studies published before April, 2015: EBSCOhost, ProQuest, and Digital Dissertation Consortium (DDC). Search terms were grouped into three categories, (*motivational* AND [*interviewing* OR *enhancement*]), [*adolescents* OR *youth* OR *young*], ([*illicit* OR *psychotropic*] AND *drug*) OR (*substance abuse*) so that hits were based on at least one keyword from each group. Studies that appeared to meet the criteria were downloaded in full text. Additionally, we hand-searched the reference lists of identified articles and systematic reviews (18, 19, 32) to identify additional articles.

2.2 Study selection

Inclusion/exclusion criteria

Studies were included in this review if: (a) the study tested an intervention or therapy based on MI or claimed to use the principles and techniques of MI or motivational enhancement therapy (MET); (b) at least one type of illicit drug was included in the study; (c) the primary outcomes included extent of drug use, intention to use drugs, and readiness for change; (d) the intervention was delivered on an individual and face-to-face basis; (e) the study design met the criteria for a randomized control trial; at least one comparison/control group, such as treatment as usual (TAU), assessment only,

educational materials only, relaxation training (RT), or no intervention; adequate measurement targeting pertinent problem areas; (f) the study reported adolescents as the target group.

Studies were excluded if they met any of the following criteria: (a) the article was based on data that was already included in another study; (b) the study did not include any illicit drugs; (c) the article was based on a sample whose average age was greater than 21 years; (d) the study did not apply random assignment to groups; (e) the study used a group MI design; (f) the study reported insufficient data about the control group, intervention group, or an associated statistic. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to identify studies and report the findings of the meta-analyses. We assessed the quality of the included studies using the Miller Quality Scoring Coding System (MQS 33).

2.3 Data-analysis plan

A data extraction form was developed to collate information from each identified randomized controlled trial. Multiple outcome measures derived from the same sample were synthesized so that each study contributed only one overall effect size to the analysis. The effect size metric used in this meta-analysis was standardized mean difference (SMD or Cohen's *d*). Before computing the average effect size for each study outcome, a positive or negative sign was assigned to each individual effect size. If means and standard deviations or Cohen's *d* were not reported, then statistical information odds ratios (OR) were used to convert to Cohen's *d*. The weighted average effect size and corresponding 95% confidence interval (95% CI) were calculated for each study outcome.

If the interval did not contain the value $d = 0$, then the null hypothesis that no relation exists in the population was rejected, and the *d* index was considered significant.

We used a fixed-effects model because it allows inferences about effect sizes to be generalized in the specific sample of studies examined (34). Cohen (35) provided guidelines for interpreting *d* effect sizes (SMD); he recommended assigning qualitative descriptors as follows: 0.20–0.49 as small, 0.50–0.79 as medium, and 0.80 and above as large. Statistically significant heterogeneity among primary outcome studies was assessed with Chi-squared (Q) tests and I-squared (36).

This meta-analysis specifically targets illicit drugs. For this reason, when studies reported multiple substances, we only used the outcome for illicit drugs. The omnibus effect size was computed by weighting each individual effect size according to the sample size. The process was completed using Review Manager 5.3.

3. Results

Figure 1 illustrates the process of study selection. A total of 159 articles that evaluated the effectiveness of MI on illicit drug use treatment were identified for further screening. After the literature search, screening, and selection, this meta-analysis included 10 studies reporting the effectiveness of MI on adolescents with illicit drug use. The quality of the 10 studies was assessed using the MQS (33). The quality scores of the 10 studies ranged from 9 to 14, and 60% ($n = 6$) of studies had a score of 10 or above ($M = 10.10$; $SD = 1.89$), indicating high study quality. All studies used randomization and a standardized treatment. Except one after-treatment assessment, all studies had good follow-up rates.

3.1 Description of Studies

Table 1 presents detailed participants characteristics for each study. One trial was a doctoral dissertation (28), and the remaining nine (90%) were published in peer-reviewed journals. There were six (60%) studies from the United States, three (30%) from the United Kingdom, and one from Taiwan. There was a total of 1,466 participants (male vs. female = 6.4:3.5). All studies reported racial demographic information. The primary participants were White (42%); others were African American (28%), mixed/others (12%), Hispanic/Latino (9%), and Asian (8%).

Table 2 lists detailed information about the intervention characteristics of the studies. Marijuana (cannabis) was the most prevalent illicit drug, represented in eight studies (80%); three studies (30%) examined the use of cocaine, and two other studies (20%) examined the use of methamphetamine/amphetamines ("ice"), and ecstasy (MDMA).

Regarding the MI interventions, seven studies (70%) administered MI within 60 minutes, and the remaining three studies (30%) involved three to four sessions. Most interventions (n = 9, 90%) used MI as a stand-alone treatment to modify drug use, and only one (37) used a telephone call booster.

3.2 Overall effect size

As Figure 2 presents, among all calculated effect sizes, 8 out of 10 (80%) were greater than zero, and half of the studies (n = 5) yielded effect sizes that were within the small and medium range (0.20–0.49 as small, 0.50–0.79 as medium, using Cohen's standards for effect-size magnitude; (35), indicating that MI achieved positive effects in most of the included studies. The overall effect sizes (d = 0.12, 95% CI [0.02, 0.22], P =

0.02) revealed a small, but significant, post-intervention effect size.

We extracted outcome data on behavior change and attitude change separately (Table 3). There was homogeneity in effect sizes ($I^2 = 0$) for both outcomes. MI manifested more promising effectiveness in improving attitude than behavioral change, with a greater effect size ($d = 0.41$, [0.18, 0.65]) and statistically significant effect ($P = 0.0005$).

3.3 Moderator analyses

To explain variation in study-level effect sizes, we examined moderator variables, the results of which are presented in Table 4. The examined moderator variables include duration of follow-up, delivery settings, and study design. The search for moderator variables allows one to uncover meaningful patterns in the data that can then be used to formulate potential causal hypotheses to be tested empirically and experimentally in subsequent research (20).

Duration of follow-up

We categorized the included studies into short follow-up (less than 6 months) or long follow-up (6 months or longer). Although the effect size of follow-ups under 6 months was small, $d = 0.11$ [-0.01, 0.23], it was greater than those occurring over a period longer than 6 months, $d = 0.05$ [-0.09, 0.18]. In addition, short follow-ups yielded greater statistical significance ($P = 0.08$) than long follow-ups ($P = 0.48$).

Delivery settings

As shown in Table 4, the I-square of the groups of clinic settings and community settings were equal to 0%, suggesting no heterogeneity. In contrast, school and incarceration settings had I-square values of 45% and 48% (25% < I^2 < 50%), which indicated moderate heterogeneity.

Based on the results in Table 4, MI interventions implemented in clinics yielded the greatest effect size (d = 0.42, 95% CI [-0.03, 0.87]); and those implemented in community-based service had the smallest effect size (d = 0.01 [-0.18, 0.20]). MI interventions had the same effectiveness in school and incarceration settings (d = 0.15). But only MI implemented in schools were significant, 95% CI [0.00, 0.29], P = 0.04. The results suggest that, when implemented in clinics, MI had greater effectiveness; when conducted in school, MI had a more significant effect.

Study designs

Table 4 presents the results of the effect sizes for different study designs. The results show that there was a small effect size for comparisons between MI and TAU, while there was no clear difference between MI and information only. In terms of comparison with other treatments, MI displayed lower effectiveness. Since there was only one study in this meta-analysis that reported the result of another treatment as a control group, there was not enough evidence to draw a conclusion.

3.4 Assessment of reporting bias

Publication bias is the phenomenon of studies with uninteresting or unfavorable results being less likely to be published than those with more favorable results (38). As the Funnel plot (Figure 3) illustrates, there is an absence on the left side at the bottom of

the funnel, resulting in asymmetry in the funnel plot. Nearly all of scattered dots are located within the triangular region defined by the outer dashed lines. The dots representing estimated effects are scattered around the overall estimate of the included studies, which is represented by the vertical line in the figure. This figure could be seen as a sign of publication bias. It is possible that studies with small sample sizes and non-significant results were not published.

4. Discussion

4.1 Overall findings

To our knowledge, this is the first meta-analysis of MI specifically for adolescents with illicit drug use. Results from this review add evidence to prior studies on the effectiveness of MI for adolescents and depict a clearer picture of MI interventions for adolescents with illicit drug use.

First, this review reports an overall small effect size (d = 0.12 [0.02, 0.22]), indicating MI interventions for adolescents' illicit drug use produced a small, but significant post-intervention effect size, which is consistent with a prior meta-analysis (d = 0.17 [0.09, 0.25]) specifically targeting adolescents' substance abuse (18). However, the overall effect size of our study was smaller than two prior meta-analyses without specified target participants (20, 22), which reported overall effect sizes of d = 0.47 and d = 0.77. This could be interpreted to mean the effectiveness of MI for adolescents was not as significant as for the general population. The developmental characteristics of adolescents may exert a moderator effect in the effectiveness of MI on illicit drug use.

Second, MI interventions were more effective in attitude change than behavior change. The results indicated that it may be more fruitful to focus on enhancing clients' motivation when implementing MI for adolescents with illicit drug use because MI interventions achieved better outcome in attitude change than behavior change. This result is consistent with several previous studies (39, 40) that found changes in motivation and behavior change were not always associated. One possible cause is measurement of change in the literature. The stages-of-change model has been criticized generally as flawed in that: change does not occur in genuine stages; it focuses too much on decision-making and not enough on implicit processes; and it may misdirect interventions (41). Additionally, in changing health-related behaviors, less time may be needed to resolve ambivalence, but more time may be needed to focus on behavioral issues (42).

4.2 Moderator findings

Compared with long follow-ups (longer than 6 months), MI was more effective in short follow-ups (less than 6 months). This result was consistent with a prior meta-analysis (22), which found a weakening of MI effects, with a reasonable but decreased outcome up to 6 months following treatment. Furthermore, this result is quite similar to a more recent meta-analysis on MI from the Cochrane Database (19). In that study, the combined result indicated that, compared to non-treatment control groups, MI showed a significant effect on substance use that was strongest post-intervention, but the effectiveness decayed with the length of follow-up interval. Conversely, another meta-analysis of adolescents (18) found that MI had significant effect sizes at both short and long follow-up intervals, suggesting that MI interventions for adolescent substance use maintain their effectiveness over time. In addition, a trial of MI for college students

showed a "sleeper effect," in which the strongest effects were identified at 15 months after brief interventions (43). This discrepancy could be due to the different characteristics of participants. Further studies should be implemented in this field before conclusions can be drawn.

To distinguish the efficacy of MI in different delivery settings, it is helpful to conduct interventions that address drug-related behavior change problems. In the present review, although interventions that took place in clinical settings yielded the greatest effect ($d = 0.36$, $P = 0.12$), most of the studies (40%) were implemented in school settings, which had smaller but statistically significant effects ($d = 0.15$, $P = 0.04$). Studies in incarceration centers performed as well as those in schools ($d = 0.15$, $P = 0.29$); and studies that took place in the community yielded the lowest effect size ($d = 0.01$, $P = 0.91$).

There are several possible explanations. First, when planning interventions for adolescents, it was easier for researchers to approach the target group in school settings. On the other hand, for the studies targeting illicit drug users, it was highly possible that the samples collected in clinic settings were clients with stronger motivation and more readiness to change. This could explain why the results in clinic settings are much better than others.

In incarceration settings, clients are strictly monitored and have limited access to drugs. MI interventions conducted in incarceration settings did not perform as well as expected. One possible explanation is that, while incarceration aims to rehabilitate and promote positive changes in youths' life trajectories, incarceration can also be a negative experience for youth (44). Another interpretation could be that it was mandatory to be

confined there and receive treatment; thus participants did not have intrinsic motivation to change.

In terms of compared effectiveness in different study designs, MI did better when compared with TAU groups (d = 0.29, P = 0.002), but was almost equivalent to "information only" (d = 0.05), and slightly less effective than other treatment (Relaxation Training; d = -0.04). The results of this meta-analysis are consistent with prior research (20, 45) that found that MI is more effective than non-treatment, but less effective when compared with other treatment. Focusing on strengthening motivation for change, MI encourages people to commit to the goal of change by expressing empathy and avoiding arguing. However, when compared to therapies that focus on behavior issues directly, the effectiveness of MI seems not optimal.

4.3 Limitations

There are several limitations of this study. First, because this field is emerging, only 10 studies were included. This means the results are based on a small number of studies, small comparison groups, and limited evidence.

Second, the funnel plot (Figure 3) generated from omnibus effect sizes suggested that there may be publication bias. In general, published studies have a larger mean effect size than unpublished studies (46), and trials with smaller sample sizes produce less precise effect estimates. Therefore, there is potential for an inflated overall effect size.

Third, for methodological reasons, the trials in the form of group interventions were not included in this review, although they had the largest effect sizes. Fourth, this study included only trials that administered MI as a stand-alone treatment, but not studies that used MI as a prelude, booster component, or other supplementary format.

Fifth, this study did not measure fidelity or retention. Most of the studies (n = 6) were single-session MI interventions and had short follow-ups (less than 6 months). The level of fidelity or retention was reported in only one study, which did not provide enough data to conduct analysis. Lastly, we only collected English articles from academic databases. Studies that reported their findings in other languages were not included. This may reject some good-quality trials and increase the risk of bias.

4.4 Future directions

The limitations in existing studies suggest several areas of future research are needed. First, research examining the moderator effects of specific characteristics of adolescents, in terms of ethnicity, gender, social, and cultural factors (such as significant others and peer support) is needed. This will provide more information that can help practitioners more precisely treat adolescents with illicit drug use. Second, future analyses of how the quality of the MI components differentially affects the content of the clinical contacts and client retention is needed.

Last but not least, the effectiveness of MI in Western countries has been well researched, but evidence of culturally adapted MI for non-English-speaking countries still remains scant. MI is a psycholinguistic counseling approach, which raises the question of how to deliver MI in specific cultural contexts and how to effectively use language to accommodate cultural beliefs, values, and attitudes of the specific target group. In addition, the variation of effectiveness and responsiveness of MI across cultures should be further studied.

In recent years, MI has been rapidly spreading as an application across Asian countries. Considering the collective nature of Asian cultures, it is possible to take a

cautious step of a paradigm shift from individualized MI interventions to Family Motivational Interviewing (FMI) and from individual motivation to collectivistic motivation in order to help adolescents with illicit drug use problems. FMI should be further developed to take into consideration culturally adapted MI in the Asian context.

The introduction of MI in clinical practice has the potential to address the epidemic of adolescent illicit drug use. This study found that most of the MI interventions were implemented in schools and exhibited a promising effect with a small but significant effect size in outcomes. School provides services that are developmentally relevant and easily accessible to adolescents. Hence more efforts need to be put forth in this field to find out how MI can be tailored according to adolescent characteristics in school-based settings.

5. Conclusions

In consideration of the results of this study, as well as the larger literature, it can be concluded that MI has the potential to be an effective treatment for adolescents with illicit drug use, with more of an effect in changing attitudes than behavior. Clinicians should consider MI as a potential treatment when offering help to adolescents with illicit drug use, and more studies on moderator effects of specific characteristics of adolescents are warranted.

Reviewed Papers

Aubrey L. L. Motivational interviewing with adolescents presenting for outpatient substance abuse treatment. (Ph.D. 9826598), The University of New Mexico. Digital Dissertation Consortium database; 1998.

Baer J. S., Garrett S. B., Beadnell B., Wells E. A., Peterson P. L. Brief motivational intervention with homeless adolescents: evaluating effects on substance use and

service utilization. *Psychol Addict Behav* 2007; **21**: 582-6. doi: http://dx.doi.org/10.1037/0893-164X.21.4.582

D'Amicoy E. J., Miles J. N. V., Stern S. A., Meredith L. S. 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.

Grenard J. L., Ames S. L., Wiers R. W., Thush C., Stacy A. W., Sussman S. Brief intervention for substance use among at-risk adolescents: a pilot study. *J Adolesc Health* 2007; **40**: 188-91.

Huang Y.-S., Tang T.-C., Lin C.-H., Yen C.-F. Effects of motivational enhancement therapy on readiness to change MDMA and methamphetamine use behaviors in Taiwanese adolescents. *Subst Use & Misuse* 2011; **46**: 411-6. doi: 10.3109/10826084.2010.501664

Marsden J., Stillwell G., Barlow H., Boys A., Taylor C., Hunt N., Farrell M. An evaluation of a brief motivational intervention among young ecstasy and cocaine users: no effect on substance and alcohol use outcomes. *Addiction* 2006; **101**: 1014-26. doi: 10.1111/j.1360-0443.2006.01290.x

McCambridge J., Slym R. L., Strang J. Randomized controlled trial of motivational interviewing compared with drug information and advice for early intervention among young cannabis users. *Addiction* 2008; **103**: 1809-18. doi: 10.1111/j.1360-0443.2008.02331.x

McCambridge J., Strang J. The efficacy of single-session motivational interviewing in reducing drug consumption and perceptions of drug-related risk and harm among young people: results from a multi-site cluster randomized trial. *Addiction* 2004; **99**: 39-52. doi: 10.1111/j.1360-0443.2004.00564.x

Stein L. A. R., Colby S. M., Barnett N. P., Monti P. M., Golembeske C., Lebeau-Craven R. Effects of motivational interviewing for incarcerated adolescents on driving under the influence after release. *Am J Addictions* 2006; **15**: 50-7. doi: 10.1080/10550490601003680

Walker D. D., Stephens R., Roffman R., DeMarce J., Lozano B., Towe S., Berg B. Randomized controlled trial of motivational enhancement therapy with nontreatment-seeking adolescent cannabis users: a further test of the teen marijuana check-up. *Psychol Addict Behav* 2011; **25**: 474-84. doi: 10.HH/j.1360-0443.2005.01139.x

References

1. United Nations Office on Drugs and Crime. World Drug Report 2014. In: Crime UNOoDa, editor. New York: United Nations publication; 2014.

2. Barlow DH, Durand VM. Abnormal Psychology: An Integrative Approach. the Fifth ed. Perkins J, editor. Belmont, CA: Wadsworth Cengage Learning; 2009.

3. Spear LP. Neurobehavioral Changes in Adolescence. Current Directions in Psychological Science. 2000;9(4):111-4.

4. Le A, Li Z, Funk D, Shram M, Li TKS. Increased vulnerability to nicotine self-administration and relapse in alcohol-naïve offspring of rats selectively bred for high alcohol intake. Journal of Neuroscience. 2006;26:1872–9.

5. Buchanan CM, Holmbeck GN. Measuring beliefs about adolescnet personality and behavior. Journal of Youth & Adolescence. 1998(27):609-29.
6. White WL. A Disease Concept for the 21st Century. Counselor. 2001(April).
7. James P, Kearns C, Campbell A, Smyth BP. Adolescents and substance use: a guide for professionals working with young poeple. London, United Kingdom: Radcliffe Publishing Ltd.; 2014.
8. Godley MD, Kahn JH, Dennis ML, Godley SH, Funk RR. The stability and impact of environmental factors on substance use and problems after adolescent outpatient treatment for cannabis abuse or dependence. Psychology of Addictive Behaviors. 2005;19(1):62-70.
9. Ngai N-p, Cheung C-k. Marginal Youth's Subcultural Factors Underlying Their Gang Involvement: A Comparative Study in Three Chineses Metropolitan Cities. International Conference on Working with Youth in a Rapidly Changing World2003.
10. Naar-King S. Motivational interviewing in adolescent treatment. Canadian Journal of Psychiatry. 2011;56(11):651-7.
11. Baer JS, Peterson PL, Wells EA. Rationale and design of a brief substance use intervention for homeless adolescents. Addiction Research & Theory. 2004;12(4):317-34.
12. D'Amico EJ, McCarthy DM, Metrik J, Brown SA. Alcohol-Related Services: Prevention, Secondary Intervention, and Treatment Preference of Adolescents. Journal of Child and Adolescent Substance Abuse. 2004;14(2):61-80.
13. Miller WR, Rollnick S. Motivational Interviewing: Helping People Change. 3rd ed: Guilford Press; 2013.
14. Miller WR, Sovereign RG, Krege B. Motivational interviewingwith problem drinkers: II.The drinker's check-up as a preventive intervention. Behavioural and Cognitive Psychotherapy. 1988;16:251.
15. Miller WR, Rollnick S. Motivational interviewing: Preparing people for change (2nd ed.). New York: Guilford; 2002.
16. Vasilaki EI, Hosier SG, W. Miles COX. The efficacy of motivational interviewing as a brief intervention for excessive dringking: A meta-analytic review. Alcohol and Alcoholism : International Journal of the Medical Council on Alcoholism. 2006;41(3):328-35.
17. Hettema JE, Hendricks PS. Motivational interviewing for smoking cessation: A meta-analytic review. Journal of Consulting and Clinical Psychology. 2010;78(6):868-84.
18. Jensen CD, Cushing CC, Aylward BS, Craig JT, Sorell DM, Steele RG. Effectiveness of motivational interviewing interventions for adolescent substance use behavior change: A meta-analytic review. J Consult Clin Psychol. 2011;79(4):433-40.
19. Smedslund G, Berg RC, Hammerstrøm KT, Steiro A, Leiknes KA, Dahl HM, et al. Motivational interviewing for substance abuse. Cochrane Database of Systematic Reviews. 2011;2011(5).
20. Burke BL, Arkowitz H, Menchola M. The efficacy of motivational interviewing: A meta-analysis of controlled clinical trials. Journal of Consulting and Clinical Psychology. 2003;71(5):843-61.
21. Lundahl BW, Kunz C, Brownell C, Tollefson D, Burke BL. A meta-analysis of motivational interviewing: twenty-five years of empirical studies. Research on Social Work Practice. 2010;20(2):137-60.
22. Hettema JE, Steele J, Miller WR. Motivational interviewing. Annual Review of Clinical Psychology. 2005;1:91-111.
23. Westra HA, Arkowitz H, Dozois DJA. Motivational Interviewing as a pretreatment to CBT for generalized anxiety disorder: Results of a randomized controlled trial. Paper presented at the

Annual Meeting of the Association for Behavioural and Cognitive Psychotherapies; Orlandoeditor2008.
24. Cushing CC, Jensen CD, Miller MB, Leffingwell TR. Meta-analysis of motivational interviewing for adolescent health behavior: Efficacy beyond substance use. Journal of Consulting and Clinical Psychology. 2014;82(6):1212-8.
25. Gayes LA, Steele RG. A meta-analysis of motivational interviewing interventions for pediatric health behavior change. Journal of Consulting and Clinical Psychology. 2014;82(3):521-35.
26. D'Amico EJ, Houck JM, Hunter SB, Miles JNV, Osilla KC, Ewing BA. Group motivational interviewing for adolescents: Change talk and alcohol and marijuana outcomes. Journal of Consulting and Clinical Psychology. 2015;83(1):68-80.
27. Tober G. Motivational interviewing with young people. In: WR M, S R, editors. Motivational interviewing: preparing people to change addictive behavior. New York: Guilford Press; 1991.
28. Aubrey LL. Motivational interviewing with adolescents presenting for outpatient substance abuse treatment [Unpublished doctoral dissertation]. United State: The University of New Mexico; 1998.
29. Mehlenbeck RS, Wember YM. Motivational interviewing and pediatric obesity. Handbook of childhood and adolescent obesity. Issues in clinical child psychology.: Springer Science + Business Media, New York, NY; 2008. p. 405-24.
30. Naar-King S. Motivational interviewing with adolescents and young adults. New York: Guilford Press; 2011.
31. Barnett E, Sussman S, Smith C, Rohrbach LA, Spruijt-Metz D. Motivational Interviewing for adolescent substance use: A review of the literature. Addictive Behaviors. 2012;37:1325-34.
32. Burke BA. Motivational interviewing: A meta-analysis of controlled clinical trials [Unpublished doctoral dissertation]: The University of Arizona, United States; 2003.
33. Miller WR, Brown J, Simpson T, Handmaker N, Bien T, Luckie L. What works? A methodological analysis of the alcohol treatment outcome literature. 2nd ed. Hester RK, Miller WR, editors. Boston: Allyn & Bacon; 1995.
34. Finney J, Moyer A. Addiction Research Methods. Miller PG, Strang J, Miller PM, editors. Chichester, West Sussex, U.K. Ames, Iowa: Wiley-Blackwell/Addiction Press; 2010.
35. Cohen J. Statistical power analysis for the behavioral sciences. 2 ed. Hillsdale, NJ: Erlbaum; 1988.
36. Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analysis. British Medical Journal. 2003:327-557.
37. Stein LAR, Colby SM, Barnett NP, Monti PM, Golembeske C, Lebeau-Craven R. Effects of motivational interviewing for incarcerated adolescents on driving under the influence after release. American Journal on Addictions. 2006;15:50-7.
38. Rothstein HR, Sutton AJ, Borenstein M. Publication bias in meta-analysis: prevention. UK: Wiley; 2005.
39. Anstiss B. An assessment of motivation and application of a motivational interviewing programme in a New Zealand offender sample [Unpublished doctoral dissertation]: Victoria University of Wellington, New Zealand; 2005.
40. Woodall WG, Delaney HD, Kunitz SJ, Westerberg VS, Zhao H. A randomized trial of a DWI intervention program for first offenders: Outcomes and interactions with antisocial personality disorder among a primarily American-Indian sample. Alcoholism: Clinical and Experimental Research. 2007(31):974-87.

41. West R. Time for a change: Putting the transtheoretical (stages of change) model to rest. Addiction. 2005;100:1036-9.
42. Resnicow K, Dilorio C, Soet J, Borrelli B, Ernst D, Hecht J, et al. Motivational interviewing in medical and public health settings. 2nd ed. Miller WR, Rollnick S, editors. New York: Guildford Press; 2002. 251-69 p.
43. White HR, Mun EY, Pugh L, Morgan TJ. Long-term effects of brief substance use interventions for mandated college students: Sleeper effects of an in-person personal feedback intervention. Alcoholism: Clinical and Experimental Research. 2007(31):1380-91.
44. Dierkhising CB, UMI Dissertations Publishing. Snare or Turning Point? An Exploration of Change and Continuity in Criminal Behavior Among Formely Incarcerated Youth [Unpublished doctoral thesis]: University of California, Riverside, United States; 2014).
45. Lundahl BW, Burke BL. The effectiveness and applicability of motivational interviewing: a practice-friendly review of four meta-analyses. Journal of Clinical Psychology. 2009;65(11):1232-45.
46. Lipsey M, Wilson D. Practical meta-analysis. California, America: Sage; 2001.

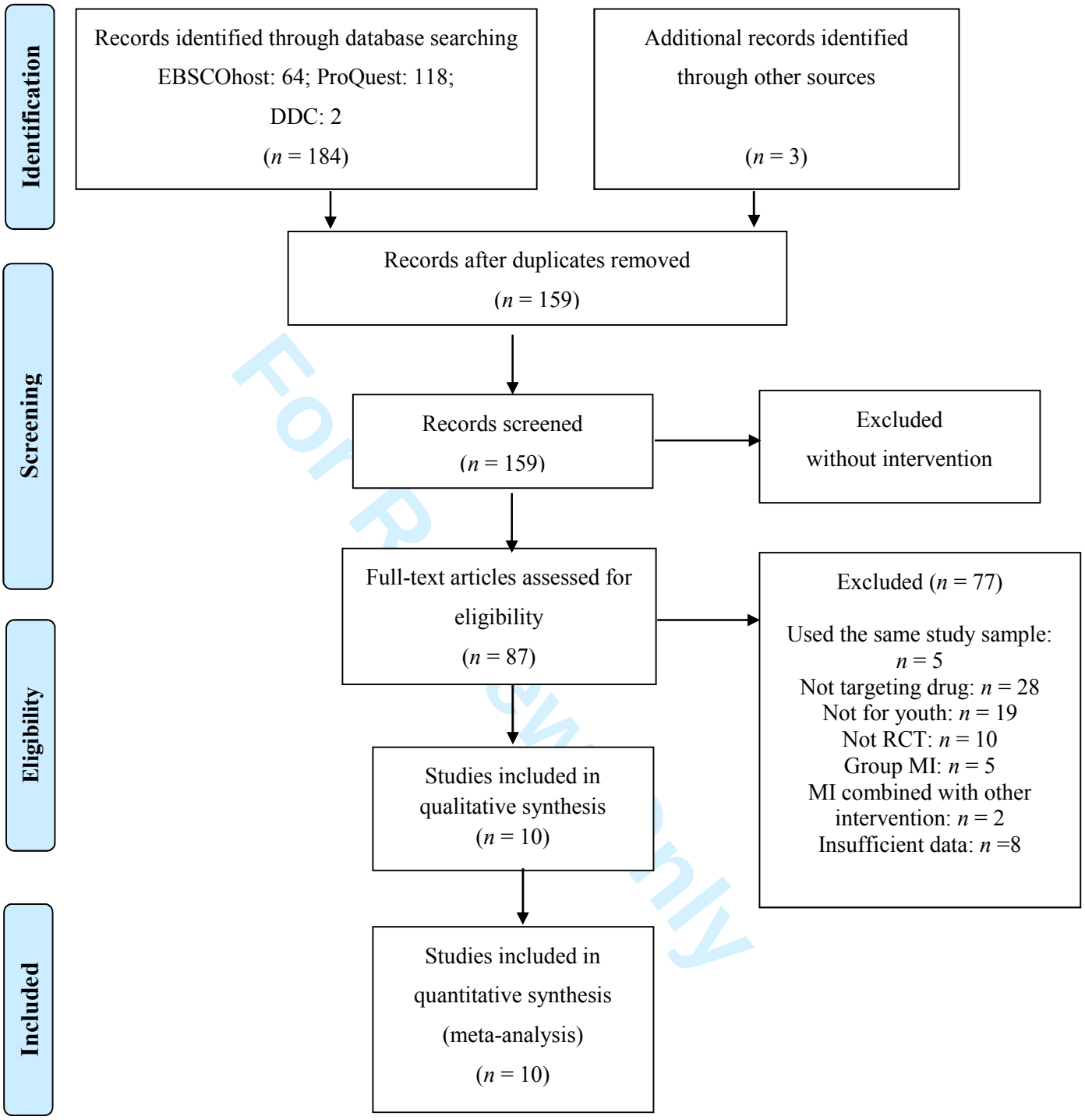

Figure 1 Study selection

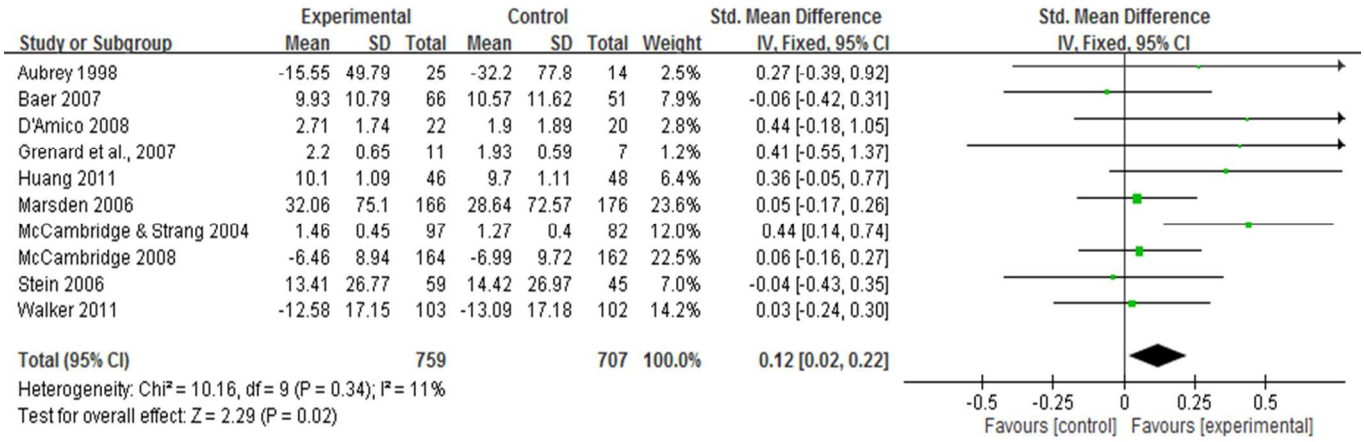

Figure 2 Weighted overall outcome effect sizes

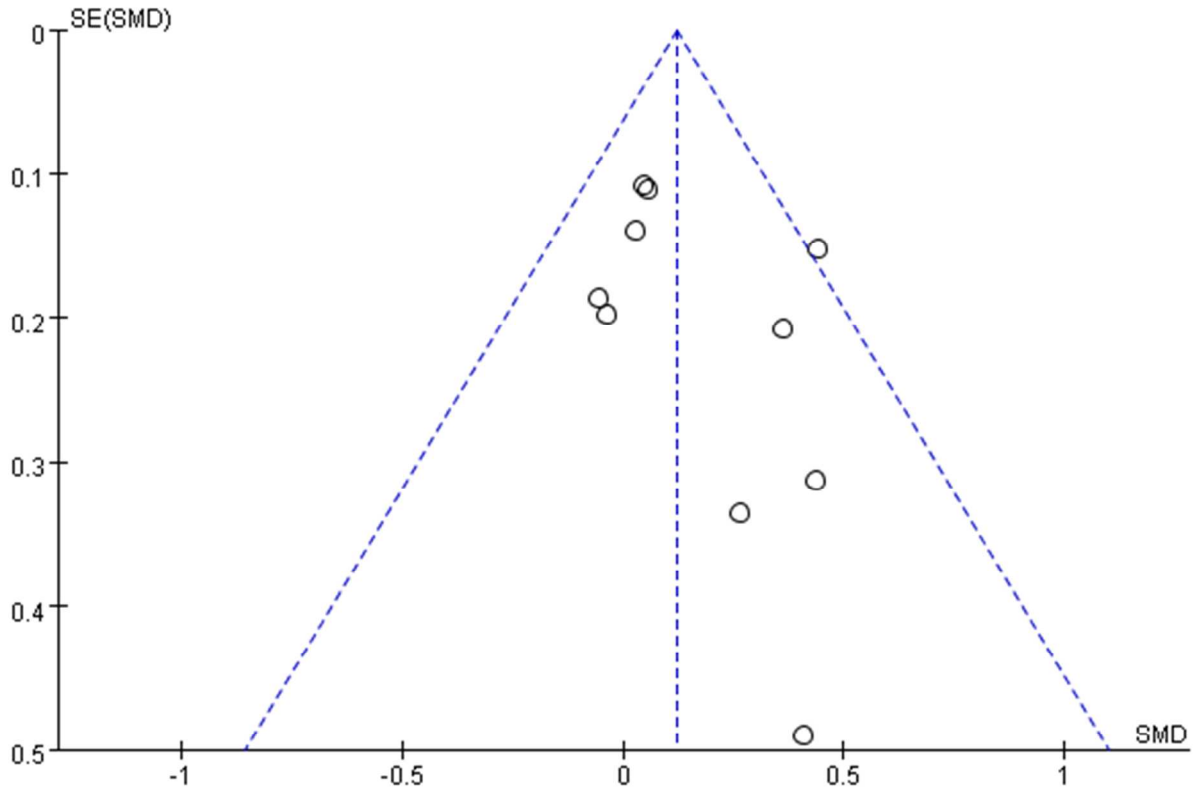

Figure 3 Assessment of publication bias

Note: WMD = weighted mean difference. Begg's funnel plot: the vertical line indicates the fixed effects pooled estimate; the dotted lines represent pseudo 95% CIs.

Table 1

Participants and demographic characteristics of included studies (N = 10)

Study	Sample used	Intervention/control	Mean age (years)	% male/% female	Ethnicity	Population	Setting
Aubrey (1998)	39	25/14	16.93	82/18	H 60%, W 33%, NA 6%, M 2%	Youth with outpatient substance abuse treatment	Outpatient clinic (US)
Baer (2007)	117	66/51	17.9	56/44	W 58%, M 19%, NA 9%, AA 8%, H/L 4%, AS 2%	Homeless youth	Nonprofit, faith-based drop-in center (US)
D'Amico (2008)	42	22/20	12-18	48/52	H 86%, AA 10%, W 5%	High-risk teens	Primary care clinic (US)
Grenard (2007)	18	11/7	16.1	67/33	L 56%, M 25%, AA 12%, W 6%	At-risk students	Continuation high schools (US)
Huang (2011)	94	46/48	16.8	48.9/51.1	AS100%	Adolescents who had used MDMA or MAMP	Abstinent center (Taiwan)
Marsden (2006)	342	166/176	18.4	66/34	W 76%, AA 11%, AS 8%, O 5%	Young ecstasy and cocaine users	Community agency (UK)
McCambridge (2004)	179	97/82	18.8	54.5/45.5	AA 50%, W 39%, O 11%	Young people currently using illegal drugs	Further education college (UK)

Table 1 (continued)

Study	Sample used	Intervention/control	Mean age (years)	% male/% female	Ethnicity	Population	Setting
McCambridge (2008)	326	164/162	18	69/31	W 11%, AA 52%, AS 19%, M/O 18%	Students who had smoked cannabis	Further education colleges (UK)
Stein et al. (2006)	104	59/45	14-19	89.5/10.5	AA 34%, H 28%, W 32%, O 6%	Incarcerated adolescents on DUI	Juvenile correctional facility (US)
Walker (2011)	205	103/102	16	60.6/39.4	W 66%, AA 10%, M 13%, AS 3%, O 5%	High-school and middle-school students	High school (US)

Note: W = White, AS = Asian; AA = Africa American; L = Latino; NA = Native American; H = Hispanic; M = Mixed; O = others.

Table 2

Intervention characteristics of included studies (N = 10)

Study	MI Condition	Control	Follow-Up	Follow-Up Intervals	Outcome of interest (drug type)	Measurements	Interventionist
Aubrey (1998)	30-60 minute personalized MI feedback	No personalized MI feedback	One-hour face-to-face interview	3 months	Marijuana	Percent days abstinent, number of treatment sessions attended	CASAA counselor, doctoral students
Baer (2007)	BMI in 4 shorter sessions	Treatment as usual	Interviews + urine sample	1 month, 3 month	Marijuana, amphetamines, cocaine, opiates	Abstinence, marijuana use, other drug use, utilization services	Master's-level clinicians
D'Amico (2008)	15-20 minute MI + booster telephone call	Care as usual	Mail questionnaires	3 months	Marijuana	Intentions to use, alcohol consumption, marijuana use	Case managers with associate degree and master's degree
Grenard (2007)	25 minutes	Care as usual	Assessment	3 months	Marijuana, club drugs, hard drugs	Frequency of drug use, problems due to drug use, readiness to change	MI Interviewer

Table 2 (continued)

Study	MI Condition	Control	Follow-up	Follow-up Intervals	Outcome of interests (drug type)	Measurements	Interventionist
Huang (2011)	3-session MET + personalized feedback	No MET	n/a	n/a	MDMA or MAMP	Readiness to change	Psychologist
Marsden (2006)	Single session	Health-risk information only	Questionnaire + interview	6 months	MDMA, cocaine powder, crack cocaine	Abstinence from substance use, changes in substance use and alcohol consumption	Youth drug workers, researchers
McCambridge (2004)	1-hour single-session face-to-face interview	Education as usual	Interviews	3 months	Alcohol, tobacco, cannabis, stimulant drug	Changes in drug use, changes in perceptions of drug-related risk	Interviewer
McCambridge (2008)	Single-session MI	Drug information and advice (DIA)	Self-report + saliva test	3 months, 6 months	Cannabis	Cannabis use, practitioner effects	Researcher practitioners, psychology graduates

Table 2 (continued)

Study	MI Condition	Control	Follow-up	Follow-up Intervals	Outcome of interests (drug type)	Measurements	Interventionist
Stein et al. (2006)	2 sessions MI	Relaxation training (RT)	Self-report + assessment	3 months	Marijuana	Depressive symptoms, number of times DUI/PUI with marijuana	Counsellors (only one with Master's degree)
Walker (2011)	Single MET or EFC session +CBT	Educational feedback/delayed feedback	Assessment	3, 12 months	Cannabis	Abstinence rates	Bachelor's- and master's-level counselors

Note: BMI = body mass index; DUI = driving under the influence; PUI = passenger in a car with someone driving under the influence.

Table 3

Outcomes analysis

Outcome Category	Study Outcomes	Effect Size (n)	Heterogeneity		Effect Size	
			I^2	*P*	*d* [95% CI]	*P*
Attitude change	Readiness to change, intention to use drug, perceptions of drug, etc.	3	0%	0.95	0.41 [0.18, 0.65]	0.0005
Behavior change	Drug use frequency, abstinence, number of dependence symptoms, problems related to drug use, etc.	8	0%	0.88	0.05 [-0.06, 0.17]	0.35

Table 4

Moderator analysis

Moderator	Subgroup	Studies (*n*)	Heterogeneity				Effect Size	
			within group		between group		*d* [95% CI]	*P*
			I^2	*P*	I^2	*P*		
Duration of follow-up	Short follow-up (< 6 months)	8	21%	0.26	0%	0.67	0.11 [-0.01, 0.23]	0.08
	Long follow-up (≥ 6 months)	3	0%	0.97			0.05 [-0.09, 0.18]	0.48
Delivery settings	Clinic	2	0%	0.71	0%	0.95	0.36 [-0.09, 0.81]	0.12
	School	4	45%	0.14			0.15 [0.00, 0.30]	0.04
	Community	2	0%	0.63			0.02 [-0.16, 0.20]	0.83
	Incarceration	2	48%	0.16			0.15 [-0.13, 0.43]	0.29
Study design	MI vs. treatment as usual (TAU)	6	0%	0.43	0%	0.96	0.29 [0.11, 0.47]	0.002
	MI vs. information only	3	0%	0.99			0.05 [-0.09, 0.18]	0.49
	MI vs. other treatment (relaxation training)	1	/	/			-0.04 [-0.43, 0.20]	0.35