Internet and Computer Based Interventions for Cannabis Use: A Meta-Analysis

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Abbreviated title: Online interventions for cannabis[1]

Word count 4654

[1] Appendices 1-3 appear as an online supplement

Abstract

Background: Worldwide, cannabis is the most prevalently used illegal drug and creates demand for prevention and treatment services that cannot be fulfilled using conventional approaches. Computer and Internet-based interventions may have the potential to meet this need. Therefore, we systematically reviewed the literature and conducted a meta-analysis on the effectiveness of this approach in reducing the frequency of cannabis use.

Methods: We systematically searched online databases (Medline, PubMed, PsychINFO, Embase) for eligible studies and conducted a meta-analysis. Studies had to use a randomized design, be delivered either via the Internet or computer and report separate outcomes for cannabis use. The principal outcome measure was the frequency of cannabis use.

Results: Data were extracted from 10 studies and the meta-analysis involved 10 comparisons with 4,125 participants. The overall effect size was small but significant, g = 0.16 (95% confidence interval (CI) 0.09-0.22 P<.001) at post-treatment. Subgroup analyses did not reveal significant subgroup differences for key factors including type of analysis (intention-to-treat, completers only), type of control (active, waitlist), age group (11-16, 17+ years), gender composition (female only, mixed), type of intervention (prevention, 'treatment'), guided versus unguided programs, mode of delivery (Internet, computer), individual versus family dyad and venue (home, research setting). Also, no significant moderation effects were found for number of sessions and time to follow-up. Finally, there was no evidence of publication bias.

Conclusions: Internet and computer interventions appear to be effective in reducing cannabis use in the short-term albeit based on data from few studies and across diverse samples.

Keywords
Meta-analysis; cannabis; Internet; systematic review, computer; intervention, prevention, substance use

1. Introduction

Globally, cannabis has a 12 month prevalence of about 4% among those aged 15-64 years (United Nations Office of Drugs and Crime, 2006a). The prevalence of past year and lifetime use of cannabis is typically higher in younger adults, thus in the USA, the lifetime and past year prevalence for those aged 18-25 years is around 51% and 30% respectively (Substance Abuse and Mental Health Services Administration, 2010). Problematic cannabis use has adverse impacts on health, mental health, cognition, social and educational outcome measures (Grant et al., 2003; Horwood et al., 2012; Kalant, 2004; Patton et al., 2002). Consequently, cannabis is second to opiates as the primary illegal drug for which treatment is sought (United Nations Office of Drugs and Crime, 2006b), with demand for treatment rising in some jurisdictions (Bonn-Miller et al., 2012; Copeland and Swift, 2009; Rotondi and Rush, 2012). However, among those meeting the criteria for cannabis abuse or dependence (American Psychiatric Association, 1994), only 6.3% received specialist treatment in the USA (Substance Abuse and Mental Health Services Administration, 2011).

Interventions for cannabis use have been developed along a continuum from universal prevention programs to treatment for those with diagnosed dependence. Prevention programs are mostly targeted at school-based groups. Given that most substance use starts in the mid-teens to early adulthood (Kessler et al., 2007) this could be regarded as a critical period in which to deliver preventive or early interventions (Zickuhr and Smith, 2012) The seminal review of school-based universal drug prevention programs found that mainly interactive programs that allow the exchange of ideas and the development of new skills were effective in reducing the use of substances including cannabis (Tobler et al., 2000). In terms of specific outcomes for cannabis, an overall effect size was estimated at $d = 0.58$ in reducing cannabis consumption (Porath-Waller et al., 2010). Few studies have evaluated the effectiveness of targeting 'high risk' students ('selective prevention'), but preliminary evidence suggests that this approach may be effective (Gottfredson and Wilson, 2003).

The effectiveness of screening and brief intervention for problematic alcohol use is well established (Moyer et al., 2002) but has not been widely tested for substance use problems, including cannabis use (Babor et al., 2007). Nevertheless, initial findings show that interventions based on cognitive behavioral therapy (CBT) and motivational enhancement therapy (MET) among non-treatment seekers (Martin and Copeland, 2008), incarcerated youth (Stein et al., 2011)

and integrated into a stepped approach leading to specialist treatment (Madras et al., 2009) can be effective in reducing the use of cannabis.

At the treatment end of the spectrum, for those with cannabis use disorders, a systematic review identified six randomized trials of psychosocial interventions (Denis et al., 2006). As with brief interventions, benefits were reported from CBT and MET. The addition of contingency management (i.e. payment for providing 'clean' urine samples) appears to increase the effect of CBT but the heterogeneity of the studies prevented a combined effect size from being calculated (Denis et al., 2006). A review by Benyamina and colleagues (2008) concluded that extended therapies which combined therapeutic approaches (i.e. CBT + MET) performed better than brief interventions and achieved reductions in cannabis use of 20-25% (Benyamina et al., 2008). Thus, in-person interventions can reduce cannabis consumption in those with diagnosed problems.

Substance users have identified numerous impediments to accessing treatment including costs, transport, inconvenience, social and work related stigma and discrimination (Substance Abuse and Mental Health Services Administration, 2011). Interventions delivered via the Internet have been posited as a means of over-coming many of these traditional barriers to accessing health services. In particular, Internet interventions can be anonymous, low-cost or free, and available whenever required. The latter factor may be especially important in addressing addiction problems, both from the perspective of being available when clients are highly motivated to commence treatment and available when the risk of relapse is high. Thus, Internet interventions may be especially relevant for addictive disorders.

There is an expanding literature on the effectiveness of Internet interventions in the treatment of a range of mental health conditions such as anxiety, depression and related problems (e.g. insomnia, stress, headaches) (Griffiths and Christensen, 2006; Griffiths et al., 2010b) plus health promotion and risk reduction interventions (Portnoy et al., 2008). Similarly, there is a sound evidence base for the use of Internet interventions in addressing problematic alcohol use. Systematic reviews report effects in the range of d = 0.12 to d = 0.42 for Internet or computer based interventions (Rooke et al., 2010; Tait and Christensen, 2010; White et al., 2010) with an analysis of unguided self-help Internet interventions for adults (excluding students) reporting an effect of g = 0.27 for single session interventions and g = 0.61 for multiple session interventions (Riper et al., 2008; Riper et al., 2011). With respect to cessation of smoking, the results have generally been positive although the magnitude of effects appears to be smaller, with a recent review reporting an effect of d = 0.14 (Rooke et al., 2010).

Internet interventions for illegal drug use, including cannabis use, are at a less mature stage of development than those for alcohol use. For example, a recent review by Gainsbury and co-workers of guided internet therapies that found no studies specifically for cannabis users that fulfilled their criteria (Gainsbury and Blaszczynski, 2011). However, this review excluded some types of intervention such as self-help and prevention programs that may be effective in reducing the use of cannabis or future demand for treatment. A review by Moore and colleagues of computer based interventions for substance use in general, including opiates, stimulants, sedatives, hallucinogens and cannabis, neither identified cannabis outcomes separately nor provided an estimate of the effect size of this approach (Moore et al., 2011).

Given the prevalence of cannabis use and unmet need for prevention and treatment programs (Rotondi and Rush, 2012; Substance Abuse and Mental Health Services Administration, 2011), the aim of this review and meta-analysis was to assemble evidence on the effectiveness of computer and Internet-based interventions in decreasing the frequency of cannabis use and to provide an estimate of the magnitude of that effect.

2. Method

2.1 Data search and criteria

In September 2012 we searched Medline, PubMed, PsychINFO (1806-2012) and Embase (1980-2012). The search terms were (substance related disorders or addiction, or abuse, or dependence or illicit) and (cannabis or marijuana or marihuana or hashish) and (Internet or web or online or computer or CD ROM) and (prevention or treatment or intervention). We also manually searched the reference lists of eligible studies. Studies were included in the meta-analysis if they 1) applied a randomized controlled design, 2) tested the effect of an Internet or computer-delivered intervention (either with or without additional therapeutic guidance) aiming at prevention, indicated prevention or treatment of substance use, 3) reported cannabis use as (one of) the outcome measure(s) and 4) provided usable data to perform the meta-analysis. We excluded interventions that were designed to improve the skills of therapists or of clients (e.g. to improve job prospects) and those measuring outcomes only as knowledge, attitudes or intentions rather than cannabis use.

Characteristics of the studies were extracted into a pre-designed form by RT including data on authors, date, location, target group, recruitment method, type of intervention and control, the

setting, mode of delivery, outcome measure(s) and time to first follow-up (Table 1). These data were checked by RS. Outcome data of the selected studies for the data synthesis were extracted into a pre-designed form by RS and checked by RT (online Appendix 1). Where data were missing or ambiguously presented, clarification was sought from the original authors.

2.2 Quality assessment and data extraction

Eligible studies were rated on the following quality criteria from the Cochrane Collaboration's tool for assessing risk of bias (Higgins and Green, 2011): random sequence generation, allocation concealment, blinding of participants, personnel and outcome assessors, and incomplete outcome data. All studies were evaluated by authors RT and RS, except Jonas (2012) which is published in German where the quality rating and data extraction were conducted by RS and HR (online Appendix 2). Disagreements were settled by consensus, with HR available as the final arbiter if required.

2.3 Meta-analysis

Analyses were performed with Comprehensive Meta-analysis (CMA) software, version 2.2064 (Biostat, 2005). To estimate the effects of cannabis interventions compared to control conditions we used the Hedges' bias-corrected effect size *g*. The frequently used effect size measure Cohen's *d*, shows a slight bias in small samples that can be corrected by applying a scaling factor. The product of *d* and this scaling factor forms the adjusted estimate *g* (Borenstein et al., 2009; Hedges and Olkin, 1985). The size of *g* indicates to what extent the intervention group differs from the control group. For example, a *g* of 0.5 implies that the mean score of the experimental group on the outcome measure is half a standard deviation higher than the mean score of the control group. In secondary meta-analyses, effects of 0.56-1.20 can be interpreted as large, 0.33-0.55 as moderate and 0.00-0.32 as small effect sizes (Lipsey and Wilson, 1993). For the calculation of the difference between conditions we used the mean outcomes at post-test assessments.

The effect size calculations were conducted on measures of self-reported cannabis use. Where a study provided multiple measures (see online appendix 1), we calculated the effect size of each measure then the mean *g* of these outcomes so that one effect size was obtained per study. Where means and standard deviations could not be retrieved, we used other statistics (*P*-values and risk ratios) which could be converted to the chosen effect size in CMA.

As studies showed large diversity in populations and types of treatments, we hypothesized variation in effect sizes and, therefore, selected the random effects model to estimate the pooled

effect size. In contrast to a fixed effects model where the pooled effect size reflects a single identical effect across studies, the random effects model estimates the mean of a distribution of effects as the pooled effect size (Borenstein et al., 2009). We further examined the heterogeneity between studies by computing Q and I^2 statistics. The Q-statistic can be used to test whether most of the disparity between studies is explained by sampling error suggesting that the hypothesis of homogeneity should be rejected (when Q is significant). The I^2 statistic provides the percentage of total variation across studies that can be ascribed to genuine differences between studies rather than caused by chance. Values of <25% are regarded as low, 25-50% as modest and >50% as high heterogeneity (Higgins et al., 2003).

To examine whether effect sizes differed according to categorical factors, we performed subgroup analyses in CMA using a random effects model with a pooled estimate of tau-squared. Variations in effect size were examined for the following subgroups: (1) type of analysis (*intention-to-treat* versus *completers only*), (2) type of control condition (*waitlist* including assessment-only versus *active* including treatment as usual and information) (3) age group (*11-16 years* versus *17 years and older*), (4) gender composition (*mixed* versus *only females)* (5) type of treatment (*universal prevention* versus *treatment* including both indicated prevention and treatment), (6) therapy guidance (*guided* versus *unguided*) (7) mode of delivery (*online* versus *off-line computer program*), (8) focus of intervention (*individual* versus *family dyad*), and (9) venue where participants received intervention (*home* versus *research setting*). We also conducted meta-regression analyses to test whether effect sizes were moderated by the following two continuous variables; (1) number of treatment sessions and (2) time to post-test.

To facilitate the interpretation of findings in terms of clinical utility, the pooled effect size was translated into the number needed to treat (NNT). The NNT shows the number of people that need to receive the intervention to get one beneficial outcome (Kraemer et al., 2006). Beneficial outcomes in this instance refer to positive effect sizes.

2.4 Publication bias

We used CMA to assess potential publication bias with a funnel plot and the Duval and Tweedie's trim-and-fill procedure (Duval and Tweedie, 2000).

2.5 Power calculation

As we expected that only a limited number of studies would meet our inclusion criteria, we calculated how many would be needed to ensure sufficient statistical power to identify relevant

effects. This was especially important because included studies were based on treatment-by-treatment comparisons, so that small effect sizes were to be expected. The power calculation was conducted according to the procedures described by Borenstein and colleagues (Borenstein et al., 2009). We hoped to find enough studies to be able to identify a small effect size of d = 0.30. The power calculations indicated that we would need to include at least fifteen studies with a mean sample size of 40 (20 participants per condition), to be able to detect an effect size of d = 0.30 (conservatively assuming a medium level of between-study variance, τ^2, a statistical power of .80 and a significance level of $\alpha < .05$). Alternatively, we would need ten studies with 60 participants each, or six studies with 100 participants, to detect an effect size of d = 0.30.

3. Results

The search produced 472 titles and/or abstracts that were inspected (Figure 1). There were 21 studies that appeared to be eligible and the full papers were assessed. Two further eligible studies were identified from reference lists. Eleven studies were excluded – the reasons for exclusion for are listed in online Appendix 3. Of the 12 reviewed studies, we excluded one from the meta-analysis because we were unable to extract the data or obtain clarification from the authors. In addition, one other study was excluded because of inconsistencies in the data that we were unable to clarify with the authors.

3.1 Description of studies contributing to data synthesis

The final selection of 10 studies (10 comparisons) included 4,125 individuals (intervention N = 2,192; control N = 1,933). The study characteristics are presented in Table 1. All studies were conducted in the past five years and took place in the USA, Germany, Australia or Canada. Study samples varied between 67 and 1,292 participants. Five studies were conducted in samples containing both males and females (N = 2,253) (Jonas et al., 2012; Kay-Lambkin et al., 2011b; Lee et al., 2010; Newton et al., 2010; Tossmann et al., 2011); the other five only recruited females (N = 1,872) (Fang et al., 2010; Ondersma et al., 2007; Schinke et al., 2009a; Schinke et al., 2009b; Schwinn et al., 2010). Study populations also differed in age group, with five studies aimed at adolescents aged 11 to 16 years (N = 2,209) and five at (young) adults aged 17 years or older (N = 1,916). Three of the studies were conducted among family dyads (Fang et al., 2010; Schinke et al., 2009a; Schinke et al., 2009b) all other studies were aimed at the individual of which two targeted school populations (Lee et al., 2010; Newton et al., 2010) and four targeted cannabis users from the general population (Jonas et al., 2012; Kay-Lambkin et al., 2011b; Ondersma et al., 2007; Tossmann et al., 2011).

Seven studies allowed comparisons with an assessment only (thus no intervention) or waitlist control group (Fang et al., 2010; Lee et al., 2010; Ondersma et al., 2007; Schinke et al., 2009a; Schinke et al., 2009b; Schwinn et al., 2010; Tossmann et al., 2011). Three studies used an active control condition. Jonas et al. (2012) provided technical information on cannabis use as a control condition. Newton and colleagues (2010) used a cluster randomized design, with control schools receiving their usual health education classes. Kay-Lambkin and colleagues (2011) used an active comparison condition comprised of either face-to-face person-centered therapy or face-to-face therapist delivered CBT with motivational interviewing.

Four studies examined an online intervention that was supported by some form of guidance from a clinician, the other six tested unguided online interventions. The five interventions classified as 'universal prevention' were based on social learning principles and consisted of a drug prevention course at school (Newton et al., 2010), a person oriented substance use prevention program for adolescent girls (Schwinn et al., 2010), and a family-oriented interactive substance use prevention program (Fang et al., 2010; Schinke et al., 2009a; Schinke et al., 2009b). Three interventions could be classified as 'indicated prevention' and were based on MI and brief intervention (BI) (Jonas et al., 2012; Lee et al., 2010; Ondersma et al., 2007). Two interventions were classified as 'treatment' and used CBT (Kay-Lambkin et al., 2011b; Tossmann et al., 2011).

3.2 Quality assessment

The studies differed in their quality (online Appendix 2). All used validated cannabis assessments and tested well-described, theory-driven interventions. Four studies applied random sequence generation. The other six studies were judged as 'unclear' due to insufficient data. Four studies concealed allocation. The remaining studies did not provide sufficient data and received the judgment 'unclear' risk of bias. The third criterion concerned whether or not participants were blind to treatment allocation. Although the difficulty of achieving this is acknowledged (Eysenbach and CONSORT-EHEALTH Group, 2011) it is occasionally possible via internet attention control interventions (Griffiths et al., 2010a) or alternative treatments. In eight studies participants would have been aware of the condition they were allocated to (e.g. assessment only), and were therefore rated as 'high risk' of bias. For the other two studies it was 'unclear' whether or not participants were blinded. With regard to the risk of bias due to incomplete outcome data, four studies were rated as 'low risk'. Two studies were evaluated as 'high risk' of incomplete outcome data because of high and / or unequal attrition rates without information about reasons for attrition. Four studies provided insufficient details to enable a rating to be made, for example, attrition rates

were low but reasons for attrition were not provided. Overall, none of the studies were rated as 'low risk' of bias on all four evaluation criteria.

Our meta-analysis contained 10 studies with a minimal sample size of 67 participants per study (the majority of studies included more than 100 participants) which allowed for sufficient power to detect a small effect size of d = 0.30.

3.3 Publication bias

The funnel plot did not demonstrate any evidence of publication bias. Further examination with the Duval and Tweedie's trim-and-fill analysis showed that the original effect size and the adjusted estimate were identical confirming that no publication bias was detected (observed at g = 0.16, 95% confidence interval (CI) 0.09-0.22, adjusted g = 0.16, 95% CI 0.09-0.22).

3.4 Effect of online cannabis interventions on self-reported cannabis use

A random effects, post-treatment analysis yielded a pooled effect size of g = 0.16 (95% CI 0.09-0.22, $P < .001$) favoring the Internet / computer interventions in reducing cannabis use, with no significant heterogeneity between studies (Q = 5.17, $P = 0.819$, $I^2 = 0.00\%$). Statistics and relative weights for each study are presented in Figure 2. The overall effect size corresponds to a NNT of 11, implying that in order to gain 1 successful treatment response, 11 participants must receive an intervention.

To further examine the stability of the overall effect size (g = .16), we determined which of the included studies had the lowest and which had the highest effect size and calculated pooled effect sizes with and without these studies. When the study with the lowest effect size (Lee et al., 2010) was excluded, the overall effect size was similar, with $g = .17$ (95% CI 0.10- 0.24, $P < .001$): the heterogeneity remained low and non-significant (Q = 3.03, $P = .932$, $I^2 = 0.00\%$). Excluding the study with the highest effect size (Schwinn et al., 2010) resulted in small reduction in effect size, with g = .14 (95% CI 0.08- 0.21, $P < .001$) and low, non-significant heterogeneity (Q = 2.70, $P = .952$, $I^2 = 0.00\%$).

3.5 Subgroup analysis and meta-regression

To examine whether the overall mean effect of the interventions differed across subgroups, we performed subgroup analyses. As shown in Table 2, results indicated no significant differences according to type of analysis, type of control condition, age group, gender composition, type of treatment, therapy guidance, mode of delivery, focus of intervention, and venue where participants

received intervention. In addition, meta-regression analyses indicated that differences in the overall mean effect size were not significantly associated with either the variation in the times to post-treatment assessments (beta = -0.00014, 95% CI = −0.01 to 0.01, *P* =.98) or the number of treatment sessions (beta = 0.00786, 95% CI = −0.01 to 0.03, *P* =.40).

4. Discussion

In this meta-analysis we found a small but significant overall effect size (*g* = 0.16) in favor of Internet / computer-based interventions in reducing the use of cannabis; this represents a NNT of about 11. The effect for Internet / computer-based cannabis interventions is smaller than the effect found for in-person interventions of *d* = 0.58 (Porath-Waller et al., 2010). However, the potential extended reach of Internet interventions means that despite a small effect at the individual level, it could have a considerable public health impact (Bennett and Glasgow, 2009). Although the contributing studies used interventions that ranged from universal prevention programs through to ones developed for those categorized as having 'harmful' levels of cannabis consumption, we found little variation in the magnitude of the effect across a range of potential moderators.

The overall effect size in reducing the frequency of cannabis use is comparable to that reported for online smoking cessation interventions (Rooke et al., 2010) but is somewhat smaller than the effect of an online single session intervention for alcohol-related problems (*g* = .27) or multiple session interventions (*g* = .61) (Riper et al., 2011). Others have reported that the length of an intervention (indexed as number of sessions) has an impact on the effectiveness of cannabis interventions. Thus, the overall effect size reported for in-person school-based programs is *d* = 0.58 in reducing cannabis use. However, the effect of interventions involving $\geq$ 15 sessions is reported as *d* = 1.40 and for those with <15 sessions, *d* = 0.10 (Porath-Waller et al., 2010). Our analysis did not replicate this finding, but the review by Porath-Waller and colleagues was restricted to school-based programs whereas the current meta-analysis included older participants and treatment-seeking groups. With respect to the NNT, a review of online alcohol interventions calculated that five people needed to use the intervention to obtain one successful outcome (Riper et al., 2011).

None of the moderators investigated in this analysis had a significant impact on the effect size, notably this included guided versus unguided programs. With respect to substance use in general and alcohol use in particular, both unguided and guided interventions have demonstrated their effectiveness (Gainsbury and Blaszczynski, 2011; Riper et al., 2011). It has been posited that some

therapist contact increases the magnitude and persistence of technology assisted interventions in reducing addictive behaviors (Newman et al., 2011). Although individual alcohol studies do report significant benefits for therapist guided compared with self-help interventions (Blankers et al., 2011) a review of alcohol and tobacco computer interventions found no advantage for guided interventions (Rooke et al., 2010), whereas a comparison of guided versus unguided internet interventions for anxiety and depression symptoms found a larger impact associated with guided therapies (Spek et al., 2007). The groups in the current review that received guided interventions ranged from a universal, school-based prevention program (Newton et al., 2009) through to those with cannabis problems (Jonas et al., 2012; Kay-Lambkin et al., 2011b). We speculate that those with more severe problems would benefit more from additional therapist assistance, so the inclusion of the school-based study, may have diluted any potential extra effect of the guided therapy. Alternatively, the high number of first time 'helpseekers' in online substance use interventions both in trials and in routine practice may differ from the characteristics of those using anxiety and depression programs (Riper et al., 2009). Furthermore, difference may not become apparent until data are available from longer duration of follow-up (Blankers et al., 2011).

Overall, the low attrition rates in most of the included studies compare favorably with other online and in-person interventions. High levels of attrition or loss to follow-up from online trials has been described as a characteristic feature of this type of intervention (Eysenbach, 2005). Yet at 12 months, three studies achieved at least 90% retention (Fang et al., 2010; Schinke et al., 2009a; Schinke et al., 2009b). Only the Tossman et al (2011) study incurred a level of attrition which would lead the validity of the outcomes to be questioned, with just 206 of 1292 (16%) people reaching the three month follow-up. Of the five in-person studies included in the review by Dutra (2008), retention ranged from 55% at 14 days (Budney et al., 2000) to 89% at 16 months (Stephens et al., 2000). It is notable that the three online trials that achieved such outstanding levels of retention all specifically recruited mother and daughter dyads. It would be useful to evaluate if this approach of including a 'significant' other would generalize to older drug users to improve retention and potentially, exposure to treatment, a method that has been used in other drug treatment interventions (Hulse et al., 2009).

4.1 Limitations

It has been noted that Internet interventions for substance use often attract participants that differ from the demographic profile seen in face-to-face clinics, in particular a greater proportion of women (White et al., 2010). In this review, four of the cannabis interventions specifically targeted only young women; this factor may limit the extent to which generalizations can be made from

these findings. A second limitation may be the restricted number of studies and heterogeneity of target populations which make generalization difficult. Nevertheless, it does provide initial data to support the use of this approach in a number of settings. These data need to be reinforced by additional studies. Third, there was some confounding of potential moderators. For example, the studies that took a prevention approach (Fang et al., 2010; Newton et al., 2010; Schinke et al., 2009a; Schinke et al., 2009b; Schwinn et al., 2010), also had the youngest participants and drew on different theoretical perspectives to the 'treatment' interventions (e.g. family interaction theory (Schinke et al., 2009b) *versus* cognitive behavioral therapy (Kay-Lambkin et al., 2011b)). Given the limited number of studies in the area, the review included both those with a prevention focus and those with a treatment orientation. Nevertheless, all studies had to include a measure of cannabis use, excluding those that only reported other types of outcome, such as intention to use (e.g. Moore (2012)). Fourth, all of our outcomes relied on self-reported data, although Ondersma (2007) did provide urinalysis as an additional outcome. While self-report is common in the substance intervention field, especially for online interventions, some studies now attempt to obtain biochemical validation, such as saliva samples (Brown et al., 2012). Inclusion of such measures in the future would help to increase confidence in the performance of online interventions, as would the use of attention control groups rather than assessment only groups. Fifth, not all of the studies specifically targeted cannabis, with some interventions assessing outcomes for a variety of substances (e.g. 'any illicit drugs'), or particular substances in addition to cannabis (e.g. alcohol) or also addressed comorbid mental health problems. Sixth, there was limited power to detect moderators, so these null findings should be interpreted with caution. Finally, as none of the studies included cannabis disorders as an entry criterion, care should be taken in generalizing the present findings to those with cannabis disorders.

4.2 Prevention and clinical implications

Internet interventions for substance related problems have been criticized for the short periods of follow-up (Tait and Christensen, 2010). However, in this review, some outcome data were available to 12 months which provide more convincing evidence that the interventions achieved meaningful behavioral change. The review identified programs that were effective as preventive interventions, including one that was evaluated within a school setting (Newton et al., 2010), suggesting the potential for widespread dissemination. We also found evidence to support their use as 'indicated prevention/treatment' including in a cohort with comorbid depression (Kay-Lambkin et al., 2011b), an important consideration given the prevalence of comorbid substance use and other mental health problems (Conway et al., 2006). The use of online delivery has been shown to be cost-effective (Blankers et al., 2012) with the potential for near zero marginal costs for

additional users, although this needs further substantiation (Tate et al., 2009). Overall, low threshold Internet-based interventions demonstrate promise for reducing the frequency of cannabis use and the potential to improve accessibility to users.

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