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Computer-Based Prevention and Intervention to Reduce Substance Use in Youth

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Abstract

Purpose of Review—Computer-based programs for substance use prevention and intervention among youth are on the ascendancy. Whether delivered by computer per se or by electronic tablet or smartphone, technology-driven programs are harmonious with how young people access information and interact with their worlds. This review examines recent evidence on computer-based programs aimed at substance use among youth, with particular attention to results from randomized trials.

Recent Findings—Outcome studies of computer-based, substance use-related programs published over the past 5 years reveal mixed results amidst diverse intervention approaches and delivery settings. Many studies are marred by high attrition. Notable in the recent literature is the international nature of technology-driven substance use prevention and intervention programs. With some exceptions, most programs appear to not have been customized for their recipient populations. Though few in number, the highest-quality studies of computer-based programs show positive outcomes in reduced substance use rates.

Summary—Based on recent findings, considerable work needs to happen before computer-delivered approaches are a proven means for reducing substance use among youth. Original programs, expressly developed for subgroups of youth, are in short supply. Though controlled designs are becoming commonplace, too many studies of computer-based programs suffer from flaws—including high rates of attrition—that limit the discovery of positive outcomes.

Keywords

Computer-based prevention and intervention; Substance use; Adolescents; Children

Introduction

Technological advances are changing how most goods and services are delivered. Unsurprisingly, the delivery of substance use prevention and intervention services efforts for youth is also employing new technologies in the form of computer-based programs. Computer-based programs offer promise to improve prevention and intervention efficacy, cost structure, logistics, responsiveness, and availability [1**]. Still, challenges remain

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Compliance with Ethical Standards

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before computer-based prevention and intervention programs realize their potential. Driving much of the research on computer-based prevention and intervention programs to reduce youthful substance use is an implied belief that technology will exert the same influence it has had on the way youth talk to their friends, do their homework, listen to music, and conduct the bulk of their quotidian affairs.

Investigators and practitioners, policy makers and program planners, and all who are concerned about substance use among children and adolescents cannot fail to see the ubiquity of technology in youths' lives. Young people live by and on their smartphones, laptops, desktops, electronic tablets, and the myriad other devices categorized as computers. Adding impetus to the exploration of computer approaches are findings that heavy use of the internet among youth, including exposure to negative role modeling, is associated with alcohol and drug use [2–6]. If computer use is linked to youthful substance use, perhaps computer technology offers a means for reducing substance use.

The Promise of Computer-Based Programs

Computer-based prevention and intervention programs to reduce substance use among youth offer hope for several reasons. Unlike classroom-based or other live delivery approaches, computer-based programs do not of necessity rely on in-person teachers, health educators, or other instructors. These intervention agents must be screened, trained, paid, and monitored. Live intervention agents can idiosyncratically interpret a prevention or intervention protocol. By misinterpreting a protocol, intervention agents can vitiate substance use reduction messages, confuse youth, and possibly cause harm. Even when delivered with fidelity, in-person programs are costly. The logistics associated with in-person programs are encountered when intervention agents attempt to bring youth together at the same time and place for their receipt of a prevention or intervention program. Moreover, in-person programs are burdensome to implement with fidelity [7, 8]. That computer-based programs address some or all of the logistical, idiosyncratic, fidelity, and other flaws that plague in-person programs partially explains the growth of computer-based prevention and intervention programs to reduce substance use among youth.

Beyond obviating the limitations of in-person programs, computer-based programs bring benefits inherent to technological innovations. Delivering prevention and intervention programs through computer-based devices is relatively inexpensive. Once a program has been developed and tested, its online dissemination costs little. Computer programs are invariably interactive. Youth can access programs through keyboards, navigational mice, and touchscreens. These features let youth respond to questions, make choices, and advance the programs as they would when playing computer games or accessing school materials. Interactivity can foster engagement, which may antecede cognitive and behavioral changes. Computer-based programs are portable, an essential advantage to exploit the omnipresence of smartphones among youth. Computer-based programs lend themselves to customization. Customizable programs can meet a youth's demographic profile and individual preferences, advantages that will only expand as programs undergo development and testing [9]. When computer-based programs are ready for dissemination, they can be embedded into a website, downloaded, or accessed through cloud services quickly and cheaply.

Computer-based programs bring advantages for investigators and for teachers, health educators, and other professionals invested in delivering evidence-based programs to youth at risk for substance use. For all of these constituencies, the high fidelity of computer-based programs is attractive. To complete a substance use reduction program, a youth may be required to correctly answer sequenced questions about the consequences of drug use, about peer pressure and refusal skills, and about steps in a cognitive problem-solving model. As the youth answers the questions, the program can record her responses, giving investigators quantified fidelity data. When the program moves to scale, those involved in its implementation can similarly monitor fidelity [1**]. Implementation integrity can be enhanced in computer-based programs when provisions are in place to limit inattention, intentionally skipped content, and overlooked material. Once a youth completes a program, those involved with it can be relatively confident that the program delivered was the program received.

Obstacles to Successful Computer-Based Programs

For the advantages of computer programs to be realized, obstacles must be overcome in developing, testing, implementing, and disseminating computer approaches to reduce adolescent substance use. Foremost is that computer-based programs are accessible only to users who possess the requisite equipment— computer, smartphone, electronic tablet, or other internet-connected device. Though most young people possess one or more of these devices, not all youths have access to the WiFi strength, hardwired connectivity, or data plans to allow the seamless transmissions that programs may require. Youths' concerns about privacy and security are impediments to computer program delivery. Understandably, youths worry that their responses to electronic surveys with questions about underage drinking, illegal drug use, and related risk-taking behaviors could fall into the wrong hands. For their part, program developers have yet to discover a foolproof means of confirming the identity of whomever is downloading their prevention and intervention content.

Other obstacles to successful computer-delivered programs arise if their implementation conditions are less than ideal. Like any interactive computer experience, computer-based prevention and intervention programs aimed at substance use rely on end users to focus on and comply with programmatic materials. If youths quickly scroll through the material, are distracted during program delivery, or fail to seriously respond to prompts, polls, and other activities in a program, they can complete a program without profiting from it. As noted, computer-based prevention and intervention programs can contain fidelity checks that let delivery agents confirm that youths completed a program. But unless these checks are sophisticated, they cannot reveal whether a youth completed a program on her own or was aided by someone else—a friend, classmate, or even a parent.

The success and viability of computer-based programs are also threatened by rapid technological changes. Like the smartphone apps that youths download, computer-based substance use prevention and intervention programs have a limited shelf life. No matter how carefully crafted, any program is captive to the technology available to developers during its construction. As soon as a program is complete, it begins its path to obsolescence. The program's clever features, engaging sights and sounds, and innovative graphics cannot long

remain fresh. When the program is tested in a clinical trial with longitudinal follow-up data, the program will be further dated before it is disseminated. Youths who interact with the tested and disseminated program may find it wanting in the latest technological features. If youths compare the program to commercial products intended for their demographic, their disappointment may deepen.

State of the Science

Despite the relative newness of computer-based prevention and intervention to reduce substance use by adolescents, reviews and meta-analyses are available on the efficacy of these programs. Appearing in 2013, a report by Champion and her associates [10] examined 12 trials of 10 school-based programs delivered online and by CD-ROM. The programs engaged students aged 10 through 16 years (total $N = 21,813$) from the US, Canada, the Netherlands, Australia, and the UK, and targeted alcohol, marijuana, and tobacco use. Limiting their analysis to seven programs that permitted the computation of effect sizes and odds ratios, Champion et al. found that six of the seven programs showed reductions in alcohol, marijuana, and tobacco use at post-intervention or follow-up. Also published in 2013, a review by Tait and colleagues [11] reviewed 10 studies involving 4,125 participants who ranged from early adolescents to young adults. The interventions were delivered online and through CD-ROM and largely focused on drug use. Across the studies, the investigators found small but significant effect sizes.

A 2014 review from Rodriguez and his associates [12] examined eight studies of computer games aimed at reducing alcohol and other drug use among youth. The studies included 3,698 adolescents aged 10 through 18 years, and employed online, CD-ROM, and other technologies. Across the studies, Rodriguez et al. found positive knowledge outcomes for six studies, improved anti-drug attitudes for two studies, and decreased drug use frequency for one study. Also appearing in 2014, a report by Wood and her colleagues [13] examined 10 studies of computer-delivered prevention and intervention programs that engaged 1,502 adolescents and 2,606 adults and that were directed at reducing illicit recreational drug use. Among other findings, Wood et al. discovered that universal prevention programs reduced the frequency of recreational drug use when measured at 12-months or longer, but not necessary at post-intervention. Other reviews of computer-based programs add support to the potential of technological approaches for preventing substance use, for intervening with substance use problems, and for promoting health among youth and adults [14–23].

Text messaging through smartphones has also been subjected to meta-analyses. Two analyses report differing conclusions. Reviewing text messaging interventions for adolescent and adult substance use, Mason and his colleagues [24] found largely positive effects from text messaging. Contrariwise, a meta-analysis by Badawy and Kuhns [25*] of text messaging and mobile phone app interventions to improve adherence to preventive behavior among adolescents reported modest results. Growing reliance on smartphones to deliver prevention and intervention programs will doubtless witness a commensurate jump in research on this technology.

Recent Studies

A compilation of recent outcome studies on computer-based substance use prevention and intervention programs for youth appears in Table 1. Included are 26 studies that: 1) reported on computer-based programs to either prevent or intervene with substance use or substance use problems, 2) focused on youth aged under 20 years (excluding college students), 3) employed randomized designs to isolate program effects, and 4) were published or accepted for publication in peer-reviewed scholarly journals between 2012 and 2017. The studies in Table 1 are organized by programs that delivered: prevention programming to youth in school (n = 17), intervention programming to youth in school (n = 1), prevention programming to youth in a non-traditional setting (n = 1), intervention programming to youths in non-traditional settings (n = 4), and prevention programming to youth in their homes (n = 3).

Reported Aims and Outcomes

Most (n = 20) of the 26 studies in Table 1 aimed to reduce substance use per se; three studies aimed at either risk factors associated with substance use (n = 1) [44] or at substance use plus a related behavior (n = 2), including energy imbalance [27] and violence [49]. Three studies aimed at either health promotion (n = 1) [29] or at non-substance use topics of HIV disease (n = 1) [47] or truancy, psychological disorders, and moral disengagement (n = 1) [34], with both of the latter studies employing substance use interventions to bring about change in their targeted non-substance use topics. Owing to their substance use reduction aims or their substance use interventions, most of the 26 studies engaged youth in the middle adolescent years (M = 14.8 years; SD = 2.05).

Outcomes reported by the studies in Table 1 encompass a range of behavioral and cognitive improvements. Behavioral outcomes included: reduced use of alcohol, cigarettes, marijuana, and prescription, psychoactive, and other drugs; lowered rates of driving under the influence, alcohol-related injuries, delinquency, truancy, HIV risk behaviors, and television viewing; increased condom use and physical activity; decreased psychological distress and moral disengagement, intentions to use drugs, peer drug use, and peer aggressiveness and victimization; and increased coping and drug use refusal skills, knowledge of substances and HIV disease, self-efficacy, peer support, problem-solving, media literacy, and self-esteem. One study [52] involved a family member in the intervention. That program increased mother-daughter closeness and communication, maternal monitoring of girls' behavior, and setting of family rules around adolescent substance use.

Computer-Based Program Delivery and Venues

Apparent in Table 1 is the diversity of computer-based programs. Whereas some programs have multiple sessions, others attempted to change youths' knowledge, attitudes, and behavior with a single session. One study [26] gave youth access to a website and encouraged them to view the modules it hosted. Ten of the programs evaluated in the 26 studies engaged adults to a lesser or greater extent to deliver computer-based programming. Those adults were professionals, including nurses (n = 1) [29], school staff and parents (n =

1) [33], teachers (n = 4) [34, 35, 38, 39], therapists (n = 3) [46, 49, 50, 51], and mothers (n = 1) [52]. A range of formats are extant in the field of computer-based programs to reduce substance use among youth.

The studies in Table 1 demonstrate how various technologies are employed in the service of substance use prevention and intervention for youth. Web-based programs completed on personal computers remain the technology of choice. Among these, the modal means for intervention delivery involves youths interacting with the program sitting at keyboards and following self-instructional prompts. In two studies [46, 49], self-instruction was compared with aided instruction in which therapists guided youths through the programmed material. Whereas Cunningham and her associates [49] found a therapist-assisted arm superior to computer-intervention alone, Walton and her colleagues [46] showed comparable results for the two modalities. The respective investigators of the studies speculate that computer interventions alone may be preferable for universal programs, and that therapist-assisted programs may be preferable for selected and indicated programs in which emotional engagement is integral. In one study in Table 1, smartphones were the preferred technology. Relative to reducing tobacco use, Mason and his colleagues [48] found that motivational interviewing messages sent to youths via smartphones were superior to health-related texts.

Though much research with adolescents occurs in schools, some of the reviewed studies were less conventionally sited. Three studies happened in hospital emergency departments [49–51] or in primary care units [46]. In these busy settings, youths could access computer programs while awaiting other services. Two studies [47, 48] took place in substance use treatment facilities or clinics, also capturing youths' attention between their receipt of clinical services. The three studies [52–54] that let youths complete their computer-based prevention programs at home engaged national U.S. samples. In these investigations, the portability advantages of computer-based approaches are manifest. Intervening with youths who are geographically dispersed is not feasible with person-delivered programs. Likewise, not restricting program delivery to such a physically defined place as a school or clinic permits flexibility that may lead to the enrollment of participants who otherwise could not join a substance use prevention or intervention program.

Another feature of the studies summarized in Table 1 is the international nature of technological advances in the delivery of prevention and intervention programs for substance use among youth. The studies are nearly evenly divided between programs located in the U.S. and those located elsewhere. Just under one-quarter of the studies were of programs located in the Netherlands. Australia accounts for three studies. Two studies occurred in Sweden, Germany, Belgium, the Czech Republic, and Romania.

Methodological Issues in Computer-Based Programs

Evident in Table 1 are disquietingly high rates of attrition (i.e., > 30%) in nine of the 26 studies [28, 31, 33, 36, 37, 39, 40, 41, 43, 45]. Small wonder that between-arm differences elude investigators when a good portion of the sample is not available for data collection. Indeed, findings summarized in Table 1 suggest that low rates of attrition are associated with outcome differences. Another feature of several studies are their large samples. Computer-

based programs clearly offer a means for concurrently reaching and intervening with great numbers of youth. The mean sample size of the total 37,040 youths represented in the 26 studies in Table 1 is 1,425. That studies with large samples appear to have suffered larger rates of attrition is probably not a coincidence.

Variations in overall quality are obvious in the corpus of recent studies of computer-based programs for substance use prevention and intervention among youth. These variations starkly emerge when methodological and substantive screening criteria are applied to the 26 studies in Table 1. Eliminating studies with attrition rates greater than 35%, for example, leaves 21 studies. Of these, eliminating studies that lack a follow-up measurement of 1 year or more leaves eight studies. Of those eight studies, seven reported behavior changes that favored youths who received prevention or intervention programming. One study [49] did not report substance use outcomes. Another study [34] did not focus on substance use outcomes—despite its testing of a substance abuse prevention program. As a consequence, five studies [27, 46, 51, 52, 54] remain that experienced attrition of 35% or less, that reported at least 1-year behavioral outcomes in substance use, and that favored youths who received the tested computer-based intervention. If the 26 studies considered for this review typify current work, research on computer-based approaches to substance use prevention and intervention among youth will advance slowly.

Conclusions

As unearthed in studies published over the last 5 years, computer-based prevention and intervention programs for substance use among youth are in their nascence. The rather leisurely pace of research advancements on computer programs for substance use problems is puzzling in light of considerable prior work on technological approaches as seen in the reviews and meta-analyses of computer programs summarized earlier. With exceptions, programs tested in recent years are underwhelming in their effects. In some instances, even modest program results on mediator and prodromal variables do not stand the test of time.

Notwithstanding their modest impact to date, recently tested computer-based approaches to substance use prevention and intervention among youth are disclosing their potential. Innovative programs are reaching youths in places that have historically not witnessed manualized substance use prevention and intervention efforts. These include hospital emergency departments, pediatric medical clinics, and youths' homes. Computer programs are engaging national samples in cost-efficient ways. Arguably, delivering interventions to national samples in any other manner than through the internet would encounter fatal logistical, cost, and quality-control barriers. Intervention fidelity is a distinct advantage of computer programs. Training protocols and implementation monitoring are similarly eased when programs are delivered by computer. When examining the recent empirical record, the promise of computer programs for substance use prevention and intervention among youth is clear, despite the absence of consistently positive outcomes.

The present review shows gaps in the development of computer-based substance use prevention and intervention programs for youth. Most recent studies evaluated programs already tested with and developed for other populations, including college students. The

absence of a guiding theoretical rationale for many computer-based substance use interventions is a weakness [55]. Though some programs have appropriately engaged special populations, greater inclusion is needed. New efforts are warranted to reach children and adolescents traditionally overlooked by computer and non-computer programs alike. These include youth outside the majority culture, whether by dint of their ethnicity or race, sexual orientation, physical abilities, or other minority group status. A characteristic of online programs is their ability to reach heretofore neglected or hidden populations who, despite their relatively small numbers, are no less deserving of expressly tailored substance use prevention and intervention programs.

Most computer-based programs summarized in this paper were brief, possibly to the detriment of their ability to affect refractory substance use behavior. Worse yet, few programs exploit the power of technology to engage adolescents in ways that youths are engaged with commercial products and educational content. Notable by their near absence are approaches that reach youths through gamification, smartphone apps, social media, and programs customized to youths' individual demography, risk factors, and vulnerabilities. Moreover, the preponderance of school-based studies in recent years suggests that computers are regarded as substitutes for teachers and health educators rather than as powerful, interactive platforms. Mobile computing in particular can expand the horizons of intervention delivery to reach youths anywhere they and their smartphones find themselves. Similarly, more programs that involve youths' parents, teachers, and other sources of guidance and social support are needed. The ease of messaging and otherwise sharing prevention and intervention content on youths' social networks would seem to invite the development of responsive programs. Simply put, the technological potential of computer-based approaches has yet to be mined.

Improvements are also warranted in the way computer-based programs for substance use prevention and intervention among youth are tested. Lacking reasonable rates of retention, investigations of computer-based programs cannot find substance use outcomes even when programs are successful. Retaining youth in clinical trials requires significant investments of human capital. The ease with which computer-based programs are delivered may result in overextended investigations that lack sufficient resources to track youths. Profitably, the large samples and small retention rates seen in a number of recent studies could be replaced by small samples and large retention rates. Indeed, roughly one-quarter (5 in 26) of recent studies that constrained attrition showed substance use behavior differences.

As computer-based approaches become more common, studies of them will expectedly become more sophisticated. Illustrative are the comparisons of efficiencies between computers and professionals as done by Cunningham et al. [49], Walton et al. [46, 50], Marsch et al. [47], Harris et al. [56], and Doumas et al. [44]. Albeit the gatekeepers of science—funding bodies, grant reviewers, journal editors and referees, as well as the consumers of science must continue to impose high standards of rigor on computer-based research, new and possibly risky initiatives must be launched and supported. These are illustrated by Mason et al.'s [48] successful test of text messaging for smoking prevention and cessation. The steady evolution of mobile computing technology is opening new venues for prevention and intervention programming.

Research on computer-based substance use prevention and intervention programs among youth will doubtless thrive and expand. As uncovered in the present review, some doubt remains about whether those programs will be responsive and efficacious. Ultimately, the only measure of programmatic success in this field is whether youth realize decreased substance use. When computer programs achieve that end, they will be hailed and embraced.

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Human and Animal Rights and Informed Consent All studies described in this paper that were performed by the authors were approved by Columbia University's Morningside Institutional Review Committee.

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Table 1

Computer-Based Substance Use Prevention and Intervention Programs for Youth (2012–2017).

	Sample (*N*)	Program Description	Comparison	Outcomes and Attrition
School-Based Prevention Programs				
Prevent smoking. Bowen et al. [26]	American Indian youth in South Dakota schools (*113*); *M* age 14.6 yrs.	Online, culturally relevant modules that youth were encouraged to visit during 1-hr. daily access periods for 6 wks.; modules asked about smoking status and provided responsive content on smoking prevention and cessation.	Online module access vs. wait-list control.	At 1 mo., intentions to try cigarettes declined; youth were more likely to help others quit smoking, and had less positive attitudes about the drug effects of smoking. Roughly one-half of youth (52%) signed into the modules at least once during intervention period. Attrition was 9%.
Reduce substance abuse and energy imbalance. Velicer et al. [27**]	Adolescents in Rhode Island schools (*4,158*); *M* age 11.4 yrs.	Five, 30-min. computer sessions; one in 6th grade, three in 7th grade, and one in 8th grade; one-half of youth received energy balance sessions and one-half received substance use prevention sessions; intervention was tailored to youths' baseline health behaviors.	Energy balance arm vs. substance use prevention arm.	At 36 mos., energy balance intervention increased physical activity and healthy diets and reduced TV time, smoking, and alcohol use. The substance use prevention program was less effective in preventing smoking and alcohol use. Attrition at 36 mos. was 28.3%.
Prevent tobacco use. Andrews et al. [28]	Oregonelementary and middle schools (*2,322*).	Computer program delivered in classroom; eight sessions in 5th grade and two boosters in 6th grade, encompassing videos, games, role-plays, and social networking activities.	Computer-based program vs. usual curriculum.	At 1 and 2 yrs., lower intentions and willingness to smoke, and positive changes in mediator variables. Attrition at 1 and 2 yrs. was 28.4% and 32.8%, respectively.
Promote health. Bannink et al. [29]	Adolescents in Dutch high schools (*1,702*); *M* age 15.9 yrs.	1. Internet program of a questionnaire with tailoring of messages, norms, and links to websites for information about alcohol, drugs, sex, bullying, mental health, and suicide; duration 45 mins. 2. Internet program plus consultation with nurse who applied motivational interviewing on risk factors identified by questionnaire.	Both interventions vs. control.	At 4 mos., internet intervention-alone increased condom use and quality of life ratings. Internet plus consultation improved mental health status. Attrition was 26.2%.
Reduce drinking. Doumas et al. [30, 31]	Adolescents in Northwestern U.S. schools (*538*); *M* age 14.2 yrs.	Online assessment and personalized normative feedback modules covering caloric and financial costs of drinking; individual drinking patterns compared to U.S. norms and local peers; risk status for negative consequences of drinking; risk avoidance strategies; information	Online program vs. usual drug and alcohol education.	At 3 mos., reduced positive alcohol expectancies and beliefs, drinking frequency, and alcohol-related consequences. No differences at 6 mos. Attrition at 3 and 6 mos. was 21% and 31%, respectively.

	Sample (*N*)	Program Description	Comparison	Outcomes and Attrition
		about alcohol; and referral information; average duration 30 mins.		
Prevent smoking. de Josselin de Jong et al. [32]	Adolescents in Dutch high schools (*6,078*); *M* age 14 yrs.	Web-based program of text, graphics, and animated videos covering awareness, motivational, and action factors, accessed through a home page and providing tailored feedback.	Web-based program vs. control.	At 6 mos., lower rates of smoking initiation for youth aged 14 to 16 yrs., but not for the total sample of youth aged 10 to 20 yrs. Attrition was 18%.
Prevent tobacco, alcohol, and cannabis use. Malmberg et al. [33]	Adolescents in Dutch high schools (*3,784*); *M* age 14 yrs.	1. Computer arm: Modules on tobacco, alcohol, and marijuana delivered over 4-mos., covering knowledge, risks, coping with peer pressure, and refusal skills delivered through films, animation, interactive tasks, and discussions in chatrooms and forums. 2. Integral arm: Same computer program plus parental participation, regulation (school standards), monitoring and counseling of training for school staff.	Both intervention arms vs. control.	No effects for either arm on tobacco, alcohol, or cannabis consumption. Attrition at 8, 20, and 32 mos. was 9.2%, 17.7%, and 33.9%, respectively.
Reduce truancy, psychological distress, and moral disengagement Newton et al. [34]	Adolescents in Australian high schools (*764*); *M* age 13.1 yrs.	Internet program of two sets of six 40-min. sessions to decrease alcohol misuse and cannabis use, followed by booster sessions 6 mos. of 15- to 20-min. cartoons showing teenagers experiencing problems with alcohol and cannabis and a compatible teacher-led activity.	Internet program vs. usual health classes.	At 12 mos., reduced truancy, psychological distress, and moral disengagement. Attrition at 12 mos. was 20.7%.
Prevent psychostimulant and cannabis use. Vogl et al. [35]	Adolescents in Australian high schools (*1,734*); *M* age 15.4 yrs.	Computer- and teacher-delivered program of six, 40-min., lessons, divided into 15- to 20 min. segments; involving cartoon depictions of high-risk situations. Classroom segment delivered by teachers involved role-plays, discussion, and skill rehearsals.	Computer- and teacher-delivered program vs. usual health curriculum control.	At post-intervention, improved psychostimulant knowledge, lower ever use and frequency of use of ecstasy, lower intentions to use psychostimulants; at 5 and 10 mos., improved cannabis knowledge; at 10-mos., less favorable attitudes toward cannabis; at post-intervention and 10-mos., less favorable attitudes toward psychostimulants. Females showed more positive changes than males. Attrition at post-intervention and 5 and 10 mos. was 15.6%, 24.6%, 28.8%, respectively.
Prevent smoking. Cremers et al. [36]	Preadolescents in Dutch elementary schools (*3,213*); *M* age 10.4 yrs.	1. Prompt arm received questionnaires and tailored feedback messages sent on 3 consecutive days plus	Both intervention arms vs. control.	No effects for either intervention at 12 or 25 mos.

	Sample (*N*)	Program Description	Comparison	Outcomes and Attrition
		six prompt messages via email and SMS each year encouraging use of intervention website. 2. No-prompt arm received same questionnaires and tailored feedback, but did not receive the additional six messages.		Attrition was 33.2% and 53.8% at 12 and 25 mos., respectively.
Prevent substance use. Arnaud et al. [37]	Adolescents in Swedish, German, Belgian, and Czech high schools (*1,449*); *M* age 16.8 yrs.	Computer program of six-motivational interviewing components presented in text and graphics; median duration 15 mins., ranging from 5 to 30 mins.	Program vs. control.	At 3 mos., reduced past-month drinking (findings not substantiated by imputed analyses). Attrition was 85.5%.
Reduce alcohol and cannabis use. Champion et al. [38]	Adolescents in Australian high schools (*1,103*); *M* age 13.3 yrs.	Twelve, 20-min. cartoon components accessed online, followed by teacher-led discussions, role-plays, and worksheet completions.	Online plus teacher intervention vs. control.	At post-intervention, increased alcohol and cannabis knowledge and decreased alcohol use and intentions to use alcohol. Attrition was 20%.
Reduce ecstasy and psychoactive substance use. Champion et al. [39]	Adolescents in Australian high schools (*1,126*); *M* age 14.9 yrs.	Four, 20-min. cartoon components accessed online, followed by optional online and teacher-delivered discussions and online worksheets.	Online plus teacher intervention vs. control.	At post-intervention, altered knowledge about psychoactive drugs and ecstasy. At 12 mos., reduced likelihood to use psychoactive substances. Attrition was 35.3% and 36.3% at post-intervention and 12-mos., respectively.
Reduce binge drinking. Jander et al. [40] Drost et al. [41]	Adolescents in Dutch high schools (2,649).	Computer game of five sessions in which youth are presented with drinking situations, asked to respond, and receive tailored feedback on their drinking behavior and plans; duration varied by youth.	Computer game vs. control.	At 4 mos., reduced binge drinking for 15- and 16-yr-olds, but not for older youth. Computer intervention was cost-effective for subgroups of adolescents. Attrition was 68.9%.
Prevent tobacco and alcohol use. Kiewik et al. [42]	Adolescents with developmental disabilities in Dutch special-needs high schools (*254*); *M* age 13.6 yrs.	Computer program of games, videos, quizzes, and examples of refusal skills; avatar provided explanations, tips, feedback, and support; youth completed program at own pace.	Computer program vs. control.	At post-intervention, improved knowledge of smoking and drinking and lower peer use of tobacco. Attrition was 17.4%.
Prevent smoking. Năděşan et al. [43]	Adolescents in Romanian high schools (*1,369*); *M* age 15.9 yrs.	Web delivery of five weekly, 45- to 50-min. sessions, covering determinants of smoking, nicotine addiction, strategies to quit and resist smoking, and dealing with stress, peer pressure, temptations, and mood changes.	Web program vs. control.	At 6 mos., reduced likelihood of smoking initiation among never-smoked youth. Lower initiation rates most pronounced for youth exposed to at least 75% of the program. Attrition was 30.7% for web arm and 20.9% for control arm.
Reduce alcohol risk factors. Doumas et al. [44]	Adolescents in Northwestern U.S. high schools (*346*); *M* age 17.2 yrs.	Online assessment and personalized normative feedback modules, including graphic depictions of the consequences of drinking in caloric	Web program vs. alcohol and drug education delivered by school counselor.	At 4 to 6 wks., reduced perceptions of peer drinking, beliefs about alcohol, and positive alcohol expectancies for females. Attrition was 23.4%.

	Sample (*N*)	Program Description	Comparison	Outcomes and Attrition
		content, physical performance, myths, peer drinking norms, beliefs, expectancies, risk factors, and potential for problems; duration 30 mins.		
School-Based Intervention Program				
Reduce heavy drinking. Voogt et al. [45]	Adolescents in Dutch preparatory and vocational schools who reported recent heavy drinking (*609*); *M* 17.3 yrs.	Web-based motivational interviewing program covering knowledge, social norms, and self-efficacy; single session of roughly 20 mins.	Web program vs. control.	At 1 mo., lowered binge drinking (in completers-only analyses; intent-to-treat analyses revealed no differences). Attrition was 35.5% and 54% at 1 and 6 mos., respectively.
Non-Traditional Setting Prevention Programs				
Prevent cannabis use. Walton et al. [46]	Adolescent patients at Midwestern U.S. urban primary care clinics *(714)*; *M 14.9* yrs.	Animated interactive program with virtual therapist; role-play scenarios; average duration 33 mins. over 2 wks.	Computer therapist vs. same program delivered by live therapist vs. control	At 3 mos., computer program lowered other drug use; at 3, 6, and 12 mos., lowered cannabis use. Live therapist intervention did not affect cannabis use, but lowered other drug use at 6 mos. and delinquency rates at 3 mos. Attrition at 3, 6, and 12 mos. was 11%, 12%, and 12%, respectively.
Non-Traditional Setting Intervention Programs				
Prevent HIV disease. Marsch et al. [47]	Adolescents in outpatient treatment in New York City (*141*); *M* age 16.4 yrs.	Web program of 26 modules on drug- and sex-related risk factors for HIV, skills for coping with HIV, and maintaining a healthy lifestyle, including a customized plan; duration 10 to 30 mins. per module.	Web-based program vs. same program delivered by prevention specialist.	At 2 weeks, web program showed increases comparable to prevention specialist in HIV/disease-related knowledge, condom use self-efficacy, condom use skills, and decreases in HIV risk behavior. Web program rated as easier to understand than prevention specialist. No attrition.
Reduce tobacco use. Mason et al. [48]	Adolescents in community substance abuse clinic in Virginia (*72*); *M* age 15.8 yrs.	Motivational interviewing (MI) of rapport building, tobacco use feedback, social network information and feedback, and plans for change, delivered by text messages to smartphones.	MI texts vs. health-related texts sent to attention control arm.	At 6 mos., MI arm decreased cigarettes smoked in past 30 days, increased intentions to not smoke, and increased peer social support. Attrition not reported.
Reduce violence and alcohol misuse. Cunningham et al. [49]	Adolescents at an emergency department who screened positive for violence and alcohol use in Michigan (*726*); *M* 16.8 yrs.	1. Computer program alone: interactive cartoons and tailored feedback. 2. Therapist-assisted: same computer program plus assistance from in-person therapist.	Computer program vs. therapist-assisted program vs. control.	At 12 mos., therapist-assisted arm reduced peer aggression and peer victimization. No differences for computer-only arm. Attrition was 16.4%.
Reduce risky drinking. Walton et al. [50] Cunningham et al. [51]	Adolescents at an emergency department who	1. Computer program of three sections covering normative feedback,	Computer program vs. therapist program aided by	Computer and therapist arms lowered rates of alcohol consumption at 3

	Sample (*N*)	Program Description	Comparison	Outcomes and Attrition
	screened positive for risky drinking in Michigan (*836*); *M* 18.6 yrs.	personal strengths, and alternatives to drinking; *M* duration 34.7 mins. 2. Therapists who led youth through the same computer program; *M* duration 45.5 mins.	computer vs. control.	mos., alcohol consequences at 3 and 12 mos., and prescription drug use at 12 mos. Computer arm lowered DUI rate at 12 mos. Therapist arm reduced frequency of alcohol-related injuries at 12 mos. Attrition was 13.2% and 12% at 3 and 6 mos., respectively.
Home-Based Prevention Programs				
Prevent substance use. Fang et al. [52]	Adolescent Asian-American girls and their mothers from across the U.S. (*108* dyads, *216* total participants); *M* 13.1 yrs.	Interactive online program of nine 35- to 45-min. sessions of audio, graphics activities to engage mothers and daughters in skills demonstrations and guided rehearsals with feedback; duration *M* = 175 days.	Online program vs. control.	At 2 yrs., daughters and mothers increased closeness and communication, maternal monitoring, and imposition of family rules against substance use. Daughters increased self-efficacy and refusal skills, lowered their intentions to use harmful substances, and reported less alcohol, marijuana, and prescription drug use. Attrition was 13.9%.
Reduce illicit drug use. Schwinn et al. [53]	Adolescents who identify as LGBTQ from across the U.S. (*236*); *M* age 16.1 yrs.	Three online sessions of interactive games, role-playing, writing activities, stress management skills, decision making, and drug refusal skills; duration of each session 14 mins. Youth took an average of 4 mos. to complete.	Online intervention vs. control.	Lower 3 mos. rates of stress, peer drug use, and 30-day other drug use, and higher coping, problem-solving, and drug refusal skills. Attrition was 15%.
Reduce drug use. Schwinn et al. [54]	Adolescent girls from across the U.S. (*788*); *M* age 13.7 yrs.	Web program of nine sessions, each requiring 15 to 20 mins. to complete, covering goal setting, body image, coping, drug knowledge, and refusal skills, and involving virtual role-playing in response to stimulus scenarios.	Web program vs. control.	At posttest, fewer cigarettes smoked and higher self-esteem, goal setting, media literacy, and self-efficacy scores. At 1 yr., less binge drinking and smoking and better marijuana refusal skills, coping skills, and media literacy and lower peer drug use. Attrition was a 2.5% and 3% at posttest and 1-yr. follow-up, respectively.