

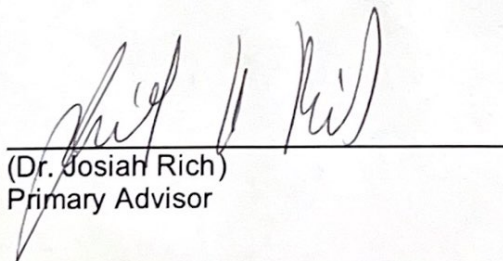
A Review of Technology-Based Interventions for the Prevention of
Adolescent Substance Use

by

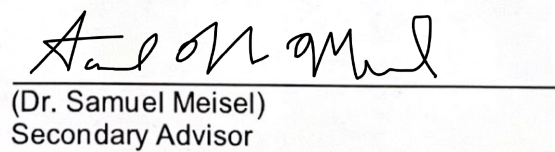
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1. Abstract

In 2021, 8.5% of adolescents in the United States were diagnosed with a substance use disorder, highlighting the need for prevention efforts. Many substance use prevention interventions utilize some form of technology, but with the rapid pace of technological advancement, the evidence is not up-to-date. This study reviewed the evidence on whether technology-based interventions are successful in preventing or reducing adolescent substance use. A search was performed using PubMed, Embase, and CINAHL. 39 randomized controlled trials met the eligibility criteria. Our results showed that computer programs ($k=13$) and websites ($k=8$) were the most common technologies used in these interventions. Across all of the studies, interventions were the most successful at increasing knowledge and changing cognitions and attitudes surrounding substance use. There was mixed evidence on the effectiveness of these interventions on adolescent substance use due to problems in study design regarding power analyses and technology utilization. More high-quality trials are warranted to assess the effectiveness of substance use prevention interventions that utilize technology.

2. Introduction

In 2021, 46.3 million people aged 12 or older (16.5% of the population) in the United States were diagnosed with a substance use disorder in the past year (Substance Abuse and Mental Health Services Administration [SAMHSA], 2021). 2.2 million of these individuals were adolescents, meaning that 8.5% of adolescents were diagnosed with a substance use disorder in 2021 (SAMHSA, 2021). Furthermore, the COVID-19 pandemic and its lingering effects of isolation and stress may lead to a new generation of adolescents that may be at greater risk for developing substance use disorders (Lundahl & Cannoy, 2021). Adolescents who use substances are at heightened risk for many problems, including sexual risk behavior, violence, mental health

problems, and suicide risks (Centers for Disease Control and Prevention [CDC], 2020).

Additionally, early drug use is associated with substance use problems later in life (Gil et al., 2004). Accordingly, preventing the onset of adolescent substance use is an important public health priority. There are a variety of prevention efforts surrounding substance use for adolescents, including universal prevention and selective prevention. Universal prevention strategies, where the whole population receives the intervention, are often used to either prevent or delay the use of substances in adolescents (Gordon, 1983; Marsch & Borodovsky, 2016). Selective prevention involves identifying and developing interventions for adolescents who are at a higher risk of developing a substance use disorder (Marsch & Borodovsky, 2016).

Technology-based interventions aimed at preventing substance use in adolescents can yield many benefits. Different types of technologies can be used, such as web-based interventions, mobile technologies, social media, virtual reality, and even gaming (Mohr et al., 2013). Adolescents' extensive use of technology can be seen as an opportunity to deliver these interventions to this demographic given the fact that most do not have access to substance use prevention programs. Only 10.6% of adolescents participated in a prevention group outside of school in 2017, and roughly two-thirds of schools do not offer evidence-based substance use prevention programming (Center for Behavioral Health Statistics and Quality, 2018; Hanley et al., 2010). Conversely, 95% of teenagers have access to a smartphone, 90% have access to a desktop or laptop computer, and 97% use the Internet daily (Atske, 2022). Furthermore, technology-based interventions are generally interactive, have a high degree of fidelity, are customizable, and are relatively inexpensive because they require less staff and resources (Schinke & Schwinn, 2017; Titov, 2007). As a result, they can also overcome geographic and socioeconomic barriers, thereby increasing intervention access (Champion et al., 2013).

However, there is mixed evidence about the effectiveness of these interventions. Web-based interventions have been used for many mental health conditions such as depression, anxiety disorders, substance use, insomnia, bipolar, and schizophrenia, and their outcomes range from no effect to effect sizes that mirror in-person interventions (Mohr et al., 2013). A review published in 2022 found that online interventions were beneficial for general and at-risk adolescents in preventing the increase in depression scores. However, they were not helpful for stress or anxiety scores (Noh & Kim, 2023). Another review that focused on computer programs to prevent the use of recreational drug use in adolescents found that while some programs were successful in reducing marijuana and polydrug use six months after the intervention, these positive effects subsided after 12 months (Wood et al., 2014). Additionally, while computerized educational games have been shown to increase knowledge about substance use among adolescents, the lack of controls in program evaluation makes it difficult to draw any definite conclusions (Rodriguez et al., 2014). Marsch and Borodovsky (2016) found examples of technology-based interventions for preventing substance use in adolescents that both reduced substance use and increased substance use prevention knowledge. However, according to Schinke and Schwinn (2017) most technology-based programs that have been tested in recent years are “underwhelming in their effects” (p.417).

Along with the mixed evidence of technology-based interventions for the prevention of adolescent substance use, there are also gaps in the literature surrounding social media. According to Marsch and Borodovsky (2016), no reviews have examined the role of social media as a mechanism to deliver substance use prevention interventions to adolescents, even though interventions through social media sites like Tumblr have been successful in improving mental health outcomes (Dobias et al., 2022). Additionally, there have been no reviews on

technology-based interventions that focus on adolescent substance use prevention in the last five years. With the rapid pace of technological advancement and the widespread adoption of technology because of the pandemic, there is a need for an up-to-date review of the currently available interventions. Given these gaps, this study will review the evidence and establish whether technology-based interventions (including those delivered via social media) are effective at preventing or reducing substance use among adolescents.

3. Methods

Literature Search and Review Procedures

An electronic search of PubMed, Embase, ERIC, and CINAHL was conducted in October 2023 (Appendix A, Table 1). The final search combined terms related to adolescents, substance use prevention interventions, and technology (e.g. “adolescent”, “teen”, “substance use prevention”, “prevention and control [MeSH]”, “technology”, or “social media”). Specific vocabulary, MeSH terms, and Emtree terms were derived from the existing literature and from a research librarian.

The titles and abstracts of identified studies were independently screened by two reviewers to assess their potential to answer the research question. Disagreements on study eligibility were reviewed by a third reviewer who made the final study determination. Titles and abstracts that did not meet inclusion criteria were removed. Full copies of the remaining relevant articles were obtained and assessed by two independent reviewers to determine whether they met the eligibility criteria. Figure 1 presents a flow chart of the search strategy and selection process.

Eligibility Criteria

This review included randomized control trials that assessed the effectiveness of a technology-based substance use intervention for adolescents. Substance use was defined as any

use of alcohol or drugs, such as marijuana or nicotine. Studies included used some sort of technology in the intervention, such as a computer module, smartphone application, social media, SMS messaging, or CD-ROM. Technology could either serve as the main treatment delivery method or serve as an adjunctive component of a prevention program. Studies not included in the intervention were those that included treatment of substance use disorders.

Adolescents were defined as children aged 10-18. Studies focused on college or university students or studies with participants diagnosed with a substance use disorder were excluded. Studies that included participants one year younger or one year older than the inclusion criteria were also included to ensure that meaningful data from these studies were included in the review. For example, if a prevention program targeting high school students included a 19-year-old, and met all other eligibility criteria, the study was included in this review. Control groups included were those with a waitlist control condition or another comparison intervention condition such as a standard health education intervention or intervention that did not use a form of technology.

The primary outcomes of interest were reported substance use and consequences after the intervention. Other secondary outcomes of interest were knowledge about substance use, perceived risk of substance use, skills acquired, plans to use substances, and indicators of well-being such as mental health symptoms, family functioning, engagement in meaningful activities, and friendship functioning after the intervention. An included study needed to have at least one of these dependent variables. There were no restrictions regarding geographical location or date in the final search. However, only studies available as full text in English were included.

Data Extraction and Assessment of Study Quality

To ensure a comprehensive review and narrative synthesis of findings, key data were extracted from each study. Information evaluated included the target group and setting, inclusion criteria, design, study time frame, participants, and underlying theory behind the intervention. Additionally, assessments of intervention details, retention, and outcome measures were also incorporated into the data extraction.

In order to measure the methodical quality and findings of each study included in the review, each study was evaluated using the *Quality Assessment Tool for Quantitative Studies* (Effective Public Health Practice Project, 2011). Studies were judged based on eight component scores for selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity, and analysis of findings. All studies then receive a singular numerical rating for methodological quality along a “strong-moderate-weak” scale, which allows for a standardized measure among all of the studies evaluated. No studies were excluded as a result of this assessment.

4. Results

622 abstracts were identified through database searches, 50 abstracts were selected for full-text review, and 39 randomized controlled trials met the eligibility criteria for inclusion in the review (Appendix B, Figure 1).

Out of the 39 studies reviewed, five interventions used a CD-ROM, eight used a website, 13 were computer-delivered, two were computer-delivered and used a CD-ROM, two used a phone application, one used SMS texting, two used a phone application and SMS texting, two used a website and SMS texting, one used a website, phone application and SMS texting, one used social media, one used a game phone app, and one used a game phone app and a website to deliver the program (Appendix C, Table 2).

Based on the *Quality Assessment Tool for Quantitative Studies* (Effective Public Health Practice Project, 2011) six studies were classified as weak, 21 studies were moderate, and 12 studies were strong.

CD-ROM (k=5)

Five studies used a CD-ROM to deliver their intervention. These studies were conducted from 2000-2007. All of them were primary prevention interventions. There was a diverse group of participants, with one study focusing solely on Black girls, and two others being majority Black. One study was primarily White and one study did not report any data on race. The interventions ranged from one 13-15 minute session to ten 45-minute sessions with an annual booster session. The majority ($k=3$) used an assessment-only control condition. Outcomes were assessed immediately after the intervention was delivered for three studies and outcomes were assessed after 3 months for one study. One study had a seven-year follow-up period and this was the only study to conduct a power analysis.

Across the five studies, seven outcomes focused on substance use, five focused on cognitions/attitudes, two focused on refusal skills, two focused on intentions, two focused on coping skills, two focused on caregiver relationships, and one focused on knowledge. There were three outcomes significant for substance use, four for cognitions/attitudes, two for refusal skills, one for intentions, two for coping skills, none for caregiver relationships, and none for knowledge. Only one study had significant findings for substance use, with the intervention significantly decreasing alcohol, binge drinking, and cigarette use. Another study did not have any significant findings for substance use but found that the intervention increased participants' ability to relax and reduce anxiety and decreased their pro-drug attitudes. Two studies did not have any significant findings whatsoever.

CD-ROM + Computer Program (k=1)

One study used a CD-ROM and a computer program to deliver the intervention. It was completed in 2005 and was a primary prevention intervention geared toward adolescent girls. The study did not report the race or ethnicity of participants. The intervention consisted of one 20-30 minute session. The control condition was a conventional drug abuse prevention program and outcomes were assessed two weeks after the intervention was delivered. A power analysis was not conducted.

In this study, four outcomes focused on intentions, three focused on cognitions/attitudes, and one focused on coping skills. All but one of the outcomes (intentions to use other drugs) assessed were significant. The study found significant findings for improving stress reduction strategies and decreasing approval of alcohol, cigarettes, and other drugs. A reduction in intentions to use cigarettes, alcohol, and marijuana was also significant.

Website (k=8)

Eight studies used a website to deliver their intervention. These studies were conducted from 2015 to 2021. All but one were primary prevention interventions ($k=7$), and one was a secondary prevention intervention. Two of the studies took place in Spain, one took place in the Czech Republic, and the rest were conducted in the United States. The studies conducted in the United States were all majority White samples. The interventions ranged from one 15-minute session to eight 30-minute sessions. All but one used an assessment-only control condition ($k=7$). One study used an educational website as the control condition. Outcomes were assessed three months after the intervention was delivered for three studies, four months for two studies, six months for one study, one year for one study, and three years for one study. Half of the studies conducted a power analysis ($k=4$).

Across the eight studies, 29 outcomes focused on substance use, four focused on cognitions/attitudes, three focused on refusal skills, one focused on intentions, one focused on

copied skills, one focused on knowledge, and two focused on well-being. There were twelve outcomes significant for substance use, one for cognitions/attitudes, two for refusal skills, none for intentions, none for coping skills, one for knowledge, and one for well-being. For substance use, there were significant findings for alcohol use, binge drinking, cigarettes, and e-cigarettes. There were no significant findings for marijuana use. In one of the studies, significant findings for alcohol use were only found in females. Out of the seven studies that assessed substance use, only one did not have any significant findings. Two studies found that the intervention condition improved refusal skills, and one study found that the intervention condition reduced anxiety and perceived stress. For the study that did not assess substance use, the intervention condition was found to significantly increase knowledge about opioids and increase negative opioid expectancies. However, positive opioid expectancies, perceived risk of opioids, and intentions to use opioids were found to not be significant.

Website + SMS Texting (k=2)

Two studies used a combination of a website and SMS texting to deliver their interventions. These studies were conducted in 2017 and 2019. One was a primary prevention intervention and the other was a secondary intervention. One study was conducted in Switzerland and had a majority Swiss sample whereas the other had a majority White sample in the United States. One intervention had one web-based session and 16 text messages while the other had four web-based sessions and 24 text messages. One intervention used an assessment-only control condition while the other used standard care. In both studies, outcomes were assessed six months after the intervention was delivered. One study conducted a power analysis.

Across both studies, four outcomes focused on substance use, four focused on cognitions/attitudes, one focused on refusal skills, and one focused on knowledge. Only one

outcome that was assessed was significant, which was decreased risky occasion drinking. All other outcomes were not significant.

Website + App (Game) (k=1)

One study used a combination of a website and a phone game to deliver the intervention. This study was conducted in 2018 and it was a primary prevention intervention. Data on participants' race was not reported. The intervention had an initial 20-minute training session and then two weeks of unlimited usage of the website and game. An assessment-only control condition was used. Outcomes were assessed two weeks after the intervention was delivered. A power analysis was conducted.

In this study, three outcomes focused on cognitions/attitudes, one focused on refusal skills, and one focused on knowledge. There were no significant findings in this study.

Computer Program (k=13)

13 studies used a computer program to deliver the intervention. These studies were conducted from 1999-2022. The majority ($k=9$) were primary prevention interventions, and four were secondary interventions. There was a diverse group of participants across all studies. Two of the studies took place in Kazakhstan and had majority Russian samples. The rest took place in the United States, and three were majority White, four were majority Black, one was majority Hispanic, and three studies did not report data about participants' race. Interventions ranged from one 20-minute session to twelve 40-minute sessions. Five studies used standard health education as a control condition, two used assessment-only, two used an intervention targeting exercise and diet, one used an unrelated computer program, one used an educational brochure, and one used a non computerized version of the intervention. Outcomes were assessed two weeks after the intervention was delivered for one study, three months for two studies, six months for four

studies, 10 months for one study, one year for two studies, two years for one study, and three years for one study. Only three studies conducted a power analysis.

Across the 13 studies, 22 outcomes focused on substance use, 10 focused on cognitions/attitudes, four focused on refusal skills, three focused on intentions, one focused on coping skills, seven focused on caregiver relationships, 10 focused on knowledge, two focused on adjustment, two focused on consequences, and one focused on well-being. There were 11 outcomes significant for substance use, six for cognitions/attitudes, three for refusal skills, one for intentions, one for coping skills, six for caregiver relationships, 10 for knowledge, two for adjustment, one for consequences, and zero for well-being. For substance use, there were significant findings for alcohol use, marijuana, binge drinking, prescription drug misuse, and e-cigarettes. There were no significant findings for cigarette use. In one of the studies, significant findings for alcohol use were only found in females. Out of the nine studies that assessed substance use, only three did not have significant findings. Two of them did not have any significant findings whatsoever, while one study found increased knowledge and increased negative attitudes about marijuana and psychostimulants. All knowledge outcomes were significant, with the interventions having been found to increase knowledge about alcohol, marijuana, psychostimulants, skills, and prescription drug misuse. All but one caregiver relationship outcomes were significant, with the interventions being found to increase communication, family rules, positive parenting, supervision, closeness, and decrease corporal punishment. The interventions were also found to increase refusal skills for alcohol and peer pressure, decrease intentions to use substances, increase coping skills for stress, increase adjustment for anger management and temper outbursts, and decrease alcohol harms (consequences) for females.

Computer Program + Website + App (k=1)

One study used a combination of a computer program, website, and app to deliver the intervention. The study was conducted in 2023 and was a primary prevention intervention. Data on participants' race was not reported. The intervention consisted of six 20-minute web-based sessions and seven 25-minute modules on the app and website. Standard health education was used as the control condition. Outcomes were assessed two years after the intervention was delivered. A power analysis was conducted.

In this study, two outcomes focused on substance use, and one focused on knowledge. There were no significant findings for substance use, but there was a significant increase in knowledge about chronic risk disease factors, including smoking and drinking.

SMS Texting (k=1)

One study used SMS texting to deliver the intervention. This study was conducted in 2021 and had a majority White sample. It was a primary prevention intervention. The intervention consisted of 14 texts sent to the participants over four weeks. The study used a wait-list control condition, and outcomes were assessed three months after the intervention was delivered. A power analysis was not conducted.

In this study, two outcomes focused on substance use, two focused on well-being, and one focused on caregiver relationships. There was one outcome significant for substance use, two for well-being, and none for caregiver relationships. The study found significant decreases in depression and anxiety for those in the intervention condition and significant odds that those in the intervention condition had lower odds of testing positive for drug use. However, overall substance use was found to not be significant.

App (k=3)

Three studies used a phone app to deliver the intervention. These studies were conducted in 2020 and 2021. The majority ($k=2$) were primary prevention interventions and one was a

secondary intervention. Two of the studies were majority White and one was focused solely on Hispanic youth. Two of the interventions involved unlimited access to the app for a year whereas the other study had ten 15-minute modules. Two studies used an assessment-only control condition while the other used standard care. Outcomes were assessed one year after the intervention was delivered for two studies and three years after for the other study. The majority ($k=2$) conducted a power analysis.

Across the three studies, five outcomes focused on substance use, four focused on refusal skills, and ten focused on adjustment. There were two outcomes significant for substance use, two for refusal skills, and none for adjustment. Only one study found significant findings, and this study found that there was decreased use of marijuana and polydrug use as well as increased self-efficacy and improved skills for refusing marijuana in the intervention condition.

App + SMS Texting ($k=2$)

Two studies used a combination of a phone app and SMS texting to deliver the intervention. These studies were conducted in 2020 and 2021. One was a primary prevention intervention and the other was a secondary one. Both were conducted in Switzerland and had majority Swiss samples. The interventions ranged from 10-20 texts to 22-44 texts in total with a baseline component on the app. Both studies used an assessment-only control condition. One study assessed outcomes immediately after the intervention and one study assessed outcomes six months after the intervention was delivered. One study conducted a power analysis and one did not.

Across both studies, six outcomes focused on substance use, one focused on well-being, and one focused on adjustment. There were two outcomes significant for substance use, one for well-being, and none for adjustment. Both studies had significant findings for substance use, with one study finding the intervention to decrease the use of alcohol. The other study found that

the intervention condition decreased the amount of alcohol consumed and decreased reported stress. However, problem drinking and other substance use (marijuana, tobacco) for the latter study were not found to be significant.

App (Game) (k=1)

One study used a phone app game to deliver the intervention. This study was conducted in 2016 and was a primary prevention intervention. It had a majority Dutch sample and took place in the Netherlands. The intervention consisted of three modules on an app. The study used an assessment-only control condition. Outcomes were assessed four months after the intervention was delivered and a power analysis was conducted.

In this study, four outcomes focused on substance use, and one of them was significant. The study found that the intervention significantly decreased binge drinking for 15-16-year-olds. However, the study did not find significant findings for binge drinking for 17-18-year-olds, excessive drinking, or weekly consumption.

Social Media (k=1)

One study used social media (a Facebook Group) to help deliver the intervention. This study was conducted in 2018 and was a primary prevention intervention. It had a majority White sample. The intervention consisted of 15 posts in the Facebook Group and two live question-and-answer sessions. Those in the control group did not have access to the Facebook Group and only had access to the prevention program. Outcomes were assessed six months after the intervention was delivered and a power analysis was conducted.

In this study, one outcome focused on cognitions/attitudes, and four focused on caregiver relationships. There were no significant findings in this study.

5. Discussion

This systematic review evaluated the evidence base for technology-assisted prevention programs for adolescent substance use. 39 studies met the inclusion criteria for the current study and reflected multiple forms of technology (e.g., computers, mobile applications, social media). Interventions included outcomes across multiple domains including substance use, cognitions/attitudes, refusal skills, intentions, coping skills, caregiver relationships, knowledge, adjustment, consequences, and well-being.

Across the 39 studies, there is mixed evidence that technology-based substance use prevention interventions are effective at preventing and reducing substance use among adolescents. Across all outcome domains, almost half (47.9%) of all intervention effects were statistically significant. However, these interventions did not have the same impact on all domains equally. The interventions we examined overall were most successful at increasing knowledge (85.7% of outcomes significant; $k=14$), increasing coping skills (80% of outcomes significant; $k=5$), and increasing refusal skills (66.7% of outcomes significant; $k=15$). They were somewhat successful at decreasing intentions to use substances (54.5% of outcomes significant; $k=11$), changing cognitions/attitudes (53.8% of outcomes significant; $k=26$), decreasing negative consequences (50% of outcomes significant; $k=2$), and increasing well-being (50% of outcomes significant; $k=8$). The interventions were least effective at increasing the quality of caregiver relationships (42.9% of outcomes significant; $k=14$), decreasing overall substance use (39.3% of outcomes significant; $k=84$), and increasing adjustment (15.4% of outcomes significant; $k=13$).

There are several possible explanations for the differences in effectiveness across outcome domains. The short-term follow-up period of several of the studies may have led to difficulties in assessing the long-term effects of the intervention on substance use. Seven studies had an immediate or two-week follow-up after the intervention was conducted to evaluate their

outcomes. These short-term follow-ups make it difficult to fully examine the intervention's effectiveness long-term and how it impacts adolescent outcomes throughout the life course. While several studies had a longitudinal design and followed adolescents for years after the intervention had finished, the short-term design of many of the studies examined is concerning as it is unclear whether the intervention prevented adolescent substance use in the following months or years. The length of follow-ups for these studies should be based on the sample age and outcomes of interest, with studies examining older adolescents' substance use prioritizing longer follow-up periods.

The success of the interventions at increasing knowledge compared to decreasing substance use goes hand in hand with previous research about health literacy and behavior change in adolescents. Multiple studies examining the relationship between health knowledge and health behavior have found that appropriate health knowledge, including information about substance use, is necessary but not sufficient to improve health-related behavior (Brandt et al., 2019; Nagy-Pénzes et al., 2020). Therefore, interventions that were able to deliver information about substance use to participants may not translate to these interventions decreasing substance use. It is important to continue to study how to facilitate behavior change from these substance use prevention programs.

It is also somewhat difficult to compare the different domain outcomes because some outcomes are represented much more than others. Substance use and cognitions/attitudes were assessed considerably more than the other outcomes, meaning that many of the studies were essentially focused on lowering negative outcomes- decreasing substance use and decreasing cognitions/attitudes favorable to substance use. While this is an important part of substance use prevention, focusing on improving positive domains such as caregiver relationships or mental

well-being is also essential. Therefore, more research is warranted on how to best improve these positive outcomes.

There were also meaningful differences in terms of effectiveness based on the technology used in the intervention. For interventions that exclusively used one technology, computer programs (64.6% of outcomes significant), SMS texting (60% of outcomes significant), and CD-ROM (56.5% of outcomes significant) were the most effective forms of technology. Interventions that utilized websites (43.9% of outcomes significant), phone games (25% of outcomes significant), or phone apps (19% of outcomes significant) were less effective. Social media was the least successful technology, with no significant outcomes. For interventions that used a combination of technologies, the combination of CD-ROM and a computer program was by far the most successful in terms of significant outcomes, with 87.5% of outcomes being significant. The combination of a computer program, website, and app (33% of outcomes significant) website and SMS texting (20% of outcomes significant), and website and a phone game (0% of outcomes significant) were the least effective.

Different levels of effectiveness due to technology may be due to study design and how interactive programs were. Studies that examined phone apps or phone games often gave participants unlimited access to these apps for a certain period. While study staff encouraged participants to use these apps, there was no specific number of sessions that study participants had to complete with the in-person supervision of a teacher or a study team member. Similarly, the study that examined the effectiveness of social media allowed participants to interact with posts in a Facebook Group but saw that very few participants were accessing the Facebook Group.

On the other hand, interventions that used a CD-ROM or computer programs were often implemented in a school or community center setting where study participants were expected to complete a certain number of sessions, often monitored by teachers and staff. In this way, these interventions may be more effective as there is more certainty that participants will complete the program instead of having to open a separate app on their phones by themselves. Therefore, these findings may not be a reflection of the effectiveness of the technology itself but rather the study design and the benefits where there is more supervision and more opportunities for adolescents to participate with others.

This problem of technology utilization of phone apps and games has been found in other reviews and is cited as a major issue for implementing these technologies in a real-life setting if people are unwilling to use the technology in the first place (O'Logbon et al., 2023). Even if these interventions were effective in a trial, whether adolescents would use them is a valid concern. Therefore, examining whether having an in-person component of the intervention to increase utilization of the technology would provide more insight into the best way to deliver these interventions, especially as some research has pointed to face-to-face interventions being more effective at reducing alcohol use among college students than computer programs (Carey et al., 2012). It also would be worthwhile to look into how often adolescents need to use technology for it to be effective. Researchers should also further examine how to design interventions that engage adolescents to mitigate utilization issues. Future research assessing the relationship between technology utilization and substance use outcomes for prevention interventions is warranted to determine how different factors impact how much time an adolescent needs to spend using technology to produce prevention benefits as well as what elements are essential to make engaging interventions.

Additionally, several other study design characteristics make it difficult to interpret the results found in this review, including the control condition. Half ($k=18$) of the studies employed an assessment-only control condition. While the other half of the studies used standard health education, informational brochures, wait lists, or a non-technology-based substance use prevention intervention, the majority of studies only compared their outcomes to a group receiving no intervention whatsoever. Somewhat surprisingly, studies that used assessment-only control conditions had less significant outcomes (43.9%) than studies that employed other types of controls (56.1%). Both studies that used assessment-only control conditions and studies that used other types of controls had a wide variety of sample sizes as well as outcome domains assessed. Therefore, the reason for this finding is unclear and warrants more research. However, it still remains that more studies are needed with more robust control groups to fully assess the intervention's effectiveness on substance use outcomes.

Only 17 studies performed a power analysis to measure their ability to detect significant differences in their outcomes across conditions. The lack of formal power analyses makes it difficult to determine whether non-significant findings were the result of interventions not successfully altering their outcomes of interest or insufficient sample sizes. Most studies did not estimate the sample size needed to conduct their trial. Several studies ($k=6$) noted that they were initial pilot studies examining the acceptability of the feasibility of their technology platform. Future tests of these technology-based prevention treatments would benefit from power analyses to provide the strongest tests of their abilities to impact their desired outcomes.

The findings from this systematic review are largely supported by other previous reviews. Other studies have found similar results surrounding the types of technology used, with Schnike and Schwinn (2017) stressing the need for more interventions that use smartphone apps,

gamification, and social media. This goes hand in hand with the findings of this review, with the majority of interventions either employing a website or computer program. Only one study in this review used social media. This is a missed opportunity considering that 98% of teenagers report using social media within the last year (Rothwell, 2023). Additionally, other reviews have similar findings regarding the types of substances targeted in substance use prevention interventions for adolescents. In a review focusing on prevention interventions aimed at illicit substances, the review found most interventions focused on marijuana despite there being many other substances that are used within the adolescent population (Dick et al., 2019). This review also supports this finding, with there being eleven outcomes specifically for marijuana use, while there were only six outcomes focused on other illicit substances. Another review found that digital interventions were effective at reducing alcohol consumption among young people, but were not successful at reducing smoking rates (O'Logbon et al., 2023). Across all of the studies in the review, interventions were more successful at reducing alcohol than smoking amongst adolescents (63% of alcohol use outcomes significant vs 38.5% of outcomes significant), providing more evidence for this finding.

Additionally, other reviews also have reported the numerous problems with study quality established previously in this paper. One review noted the poor quality of many studies assessing illicit substance use prevention interventions for adolescents, adding that more studies were needed that were sufficiently powered and had an adequate follow-up period to examine intervention effects long term (Dick, 2019). Another review further emphasized that improvements are needed in how computer-based substance use prevention interventions are tested (Schnike & Schwinn, 2017). These findings go hand in hand with those found in this

review, with this review also citing the need for more robust control conditions to further increase study quality.

However, this review is not without limitations. Our search was limited to three academic databases (PubMed, Embase, and CINAHL). We could not examine other relevant databases such as APA Psyc or MEDLINE which may have provided additional studies that met the inclusion criteria. Additionally, we only included studies that were written in English. There may have been studies that met our inclusion criteria in other languages that we did not have access to. We also did not formally analyze the content in the interventions, which could provide greater insight into what makes certain interventions successful. Finally, we did not conduct a meta-analysis of our studies, making it more difficult to fully assess the effectiveness of these interventions.

6. Conclusion

This systematic review aimed to explore if technology-based substance use prevention interventions were successful at preventing or reducing substance use in adolescents. 39 studies were eligible for the review. Overall, a little less than half (47.9%) of the outcomes assessed across all studies were significant, suggesting there is mixed evidence that these interventions can be successful at reducing substance use. However, problems associated with study quality including inadequate power analyses, follow-up periods, and control conditions indicate that more high-quality studies are needed to fully assess the effectiveness of these interventions. Technology-delivered interventions have the potential to deliver effective programs that reach more adolescents and utilize relatively few resources. Therefore, future studies must be more robust in their evaluation of these interventions to better determine the effective components of technology-based substance use prevention interventions.

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APPENDICES

Appendix A: Table 1: Full Search Protocol

Appendix B: Figure 1: Systematic Search Flowchart

Appendix C: Table 2: Description of Included Studies

Appendix D: Table 3: Quality Assessment

Appendix A: Table 1: Full Search Protocol

	PubMed (searched October 24 2023)	Embase (searched October 19 2023)	CINAHL (searched October 20 2023)
Adolescents	1. "Adolescent"[Mesh]] OR adolescen*[Title/Abstract] OR teen*[Title/Abstract] OR youth*[Title/Abstract]] OR middle school*[Title/Abstract]] OR high school*[Title/Abstract]] OR junior high school*[Title/Abstract]]	1. 'adolescent'/exp OR 'adolescent' OR adolescen*:ti,ab OR teen*:ti,ab OR youth*:ti,ab OR 'middle school*':ti,ab OR 'high school*':ti,ab OR 'junior high school*':ti,ab	1. AB (TI adolescen* OR AB adolescen*) OR (TI teen* OR AB teen*) OR (TI youth* OR AB youth*) OR (TI "middle school*" OR AB "middle school*") OR (TI "high school*" OR AB "high school*") OR (TI "junior high school*" OR AB "junior high school*")
Substance Use Prevention Interventions	2. addiction prevention program*[Title/Abstract]] OR addiction prevention strateg*[Title/Abstract]] OR universal program*[Title/Abstract]] OR universal prevention strateg*[Title/Abstract]] OR substance use prevention*[Title/Abstract]] OR selective substance use prevention program*[Title/Abstract]] OR selective substance use prevention strateg*[Title/Abstract]]	2. 'addiction prevention program*':ti,ab OR 'addiction prevention strateg*':ti,ab OR 'universal program*':ti,ab OR 'universal prevention strateg*':ti,ab OR 'substance use prevention*':ti,ab OR 'secondary substance use prevention program*':ti,ab OR 'secondary substance use prevention strateg*':ti,ab	2. AB (TI "addiction prevention program*" OR AB "addiction prevention program*") OR (TI "addiction prevention strateg*" OR AB "addiction prevention strateg*") OR (TI "universal program*" OR AB "universal program*") OR (TI "universal prevention strateg*" OR AB "universal prevention strateg*") OR (TI "substance use prevention*" OR AB "substance use prevention*")
	3. addiction prevention[Title/Abstract]	3. 'addiction prevention':ti,ab	3. AB (TI "addiction prevention" OR AB

	ract] AND (program*[Title/Abstract] OR strateg*[Title/Abstract] OR cours*[Title/Abstract] OR resourc*[Title/Abstract] OR curriculum*[Title/Abstract] OR educat*[Title/Abstract] OR plan*[Title/Abstract] OR module*[Title/Abstract])	AND (program*:ti,ab OR strateg*:ti,ab OR cours*:ti,ab OR resourc*:ti,ab OR curriculum*:ti,ab OR educat*:ti,ab OR plan*:ti,ab OR module*:ti,ab)	"addiction prevention") AND ((TI program* OR AB program*) OR (TI strateg* OR AB strateg*) OR (TI cours* OR AB cours*) OR (TI resourc* OR AB resourc*) OR (TI curriculum* OR AB curriculum*) OR (TI educat* OR AB educat*) OR (TI plan* OR AB plan*) OR (TI module* OR AB module*))
	4. universal prevention[Title/Abstract] AND (program*[Title/Abstract] OR strateg*[Title/Abstract] OR cours*[Title/Abstract] OR resourc*[Title/Abstract] OR curriculum*[Title/Abstract] OR educat*[Title/Abstract] OR plan*[Title/Abstract] OR module*[Title/Abstract])	4. 'universal prevention':ti,ab AND (program*:ti,ab OR strateg*:ti,ab OR cours*:ti,ab OR resourc*:ti,ab OR curriculum*:ti,ab OR educat*:ti,ab OR plan*:ti,ab OR module*:ti,ab)	4. AB (TI "universal prevention" OR AB "universal prevention") AND ((TI program* OR AB program*) OR (TI strateg* OR AB strateg*) OR (TI cours* OR AB cours*) OR (TI resourc* OR AB resourc*) OR (TI curriculum* OR AB curriculum*) OR (TI educat* OR AB educat*) OR (TI plan* OR AB plan*) OR (TI module* OR AB module*))
	5. substance use prevention[Title/Abstract] AND (program*[Title/Abstract] OR strateg*[Title/Abstract] OR cours*[Title/Abstract]	5. 'substance use prevention':ti,ab AND (program*:ti,ab OR strateg*:ti,ab OR cours*:ti,ab OR resourc*:ti,ab OR curriculum*:ti,ab OR educat*:ti,ab OR	5. AB (TI "substance use prevention" OR AB "substance use prevention") AND ((TI program* OR AB program*) OR (TI strateg* OR AB strateg*) OR (TI

	OR resourc*[Title/Abstract] OR curriculum*[Title/Abstract] OR educat*[Title/Abstract] OR plan*[Title/Abstract] OR module*[Title/Abstract])	plan*:ti,ab OR module*:ti,ab)	cours* OR AB cours*) OR (TI resourc* OR AB resourc*) OR (TI curriculum* OR AB curriculum*) OR (TI educat* OR AB educat*) OR (TI plan* OR AB plan*) OR (TI module* OR AB module*))
	6. selective substance use prevention [Title/Abstract] AND (program*[Title/Abstract] OR strateg*[Title/Abstract] OR cours*[Title/Abstract] OR resourc*[Title/Abstract] OR curriculum*[Title/Abstract] OR educat*[Title/Abstract] OR plan*[Title/Abstract] OR module*[Title/Abstract])	6. 'secondary substance use prevention':ti,ab AND (program*:ti,ab OR strateg*:ti,ab OR cours*:ti,ab OR resourc*:ti,ab OR curriculum*:ti,ab OR educat*:ti,ab OR plan*:ti,ab OR module*:ti,ab)	6. (TI "secondary substance use prevention" OR AB "secondary substance use prevention") AND ((TI program* OR AB program*) OR (TI strateg* OR AB strateg*) OR (TI cours* OR AB cours*) OR (TI resourc* OR AB resourc*) OR (TI curriculum* OR AB curriculum*) OR (TI educat* OR AB educat*) OR (TI plan* OR AB plan*) OR (TI module* OR AB module*))
	7. #2 OR #3 OR #4 OR #5 OR #6	7. #2 OR #3 OR #4 OR #5 OR #6	7. #2 OR #3 OR #4 OR #5 OR #6
	8. "Behavior, Addictive/prevention and control"[Mesh] OR "Substance-Related Disorders/prevention and control" [Mesh]	8. 'drug dependence'/exp OR 'drug dependence' AND 'prevention and control'/exp OR 'prevention and control'	n/a
	9. #8 AND	n/a	n/a

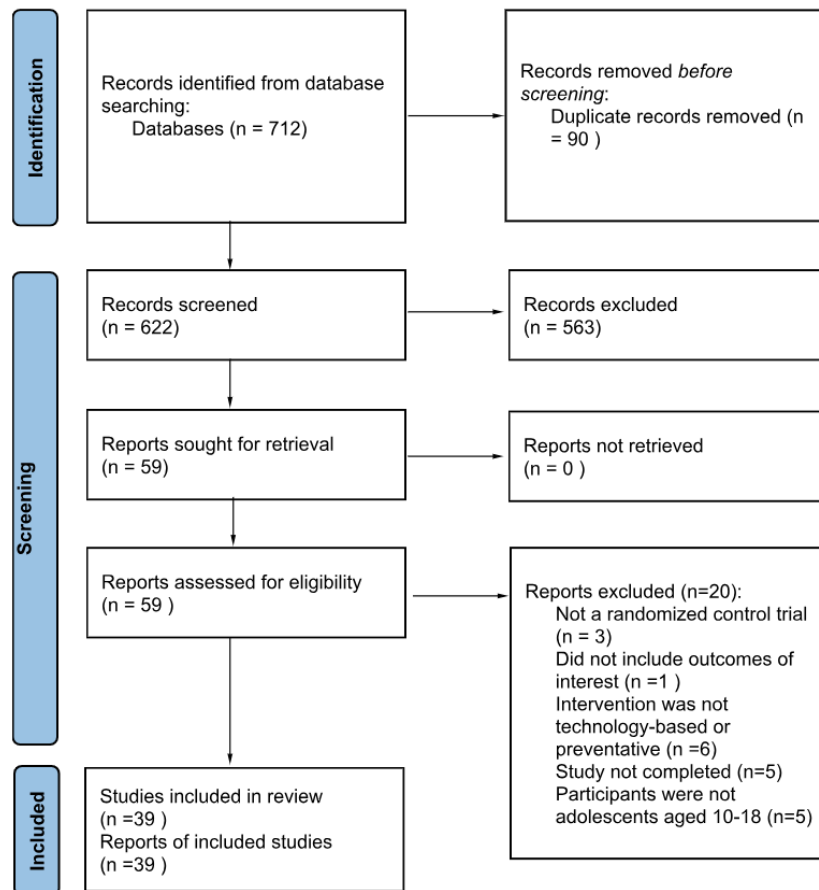
	(program*[Title/Abstract] OR strateg*[Title/Abstract] OR cours*[Title/Abstract] OR resourc*[Title/Abstract] OR curriculum*[Title/Abstract] OR educat*[Title/Abstract] OR plan*[Title/Abstract] OR module*[Title/Abstract])		
	10. #7 OR #9	9. #7 OR #8	n/a
Adolescents + Substance Use Prevention Intervention	11. #1 AND #10	10. #1 AND #9	8. #1 AND #8
Technology	12.(("Technology"[Major]) OR "Educational Technology"[Mesh]) OR "Communications Media"[Mesh]	11. 'mass medium'/exp OR 'mass medium' OR 'technology'/exp OR 'technology'	9. TI technology OR AB technology) OR (TI technologies OR AB technologies) OR (TI "social media" OR AB "social media") OR (TI computer OR AB computer) OR (TI blog OR AB blog) OR (TI Facebook OR AB Facebook) OR (TI Instagram OR AB Instagram) OR (TI Snapchat OR AB Snapchat) OR (TI Twitter OR AB Twitter) OR (TI TikTok OR AB TikTok) OR (TI YouTube OR AB YouTube) OR (TI

			website* OR AB website*) OR (TI webpage* OR AB webpage*) OR (TI "mobile device*" OR AB "mobile device*") OR (TI "mobile technology" OR AB "mobile technology")
	13. technology[Title/Abstract] OR technologies[Title/Abstract] OR "social media"[Title/Abstract] OR computer[Title/Abstract] OR blog[Title/Abstract] OR Facebook[Title/Abstract] OR Instagram[Title/Abstract] OR Snapchat[Title/Abstract] OR Twitter[Title/Abstract] OR TikTok[Title/Abstract] OR YouTube[Title/Abstract] OR website*[Title/Abstract] OR webpage*[Title/Abstract] OR mobile device*[Title/Abstract] OR mobile technology[Title/Abstract]	12. technology:ti,ab OR technologies:ti,ab OR 'social media':ti,ab OR computer:ti,ab OR blog:ti,ab OR facebook:ti,ab OR instagram:ti,ab OR snapchat:ti,ab OR twitter:ti,ab OR tiktok:ti,ab OR youtube:ti,ab OR website*:ti,ab OR webpage*:ti,ab OR 'mobile device*':ti,ab OR 'mobile technology':ti,ab	n/a
	14. #12 OR #13	13. #11 OR #12	n/a
Adolescents +	15. #11 AND #14	14. # 10 AND #13	10. #8 AND #9

Substance Use Intervention + Technology			
Total Results	371	297	44

Appendix B: Figure 1: Systematic Search Flowchart

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: <http://www.prisma-statement.org/>

Appendix C: Table 2: Description of Included Studies

Author/ Date	N	M age	Mal e %	Race/ Ethnic ity	Prevent ion Type	Program Name & Dose	Contrast Condition	Follow -Up Period	Power Analysis	Main Findings
CD ROM										
Duncan 2000	74	15. 2	16.1	Not reporte d	Primary	n/a: 6 sessions	assessment only	immed iate	no	● refusal skills- efficacy marijuana + ● intentions- marijuana _ ● cognitions/attitudes- social norms + ● substance use- smoking ● substance use- alcohol ● substance use- marijuana ● substance use- inhalant ● cognitions/attitudes - pro-drug attitudes _ ● cognitions/attitudes - peer drug norms _ ● cognitions/attitudes - adult drug norms _ ● coping skills - relaxation skills knowledge ● coping skills - anxiety reduction skills
Williams 2005	123	n/a	50	White: 75.6%	Primary	LifeSkills Training CD-ROM: 10 sessions	wait-list control	immed iate	no	● caregiver relationship-communication ● caregiver relationship-closeness ● intentions- substance use ● cognitions/attitudes- commitment to avoid substance use ● knowledge- links between alcohol and diet and exercise
Schnike 2006	86	10. 4	0	Black: 100%	Primary	n/a: 5 sessions	assessment only	3 months	no	
Mathews 2007	217	n/a	47	Black: 51.8% White: 32% Hispanic: 6.6%	Primary	Project Sport: 1 13-15 minute session	standard health education computer program	immed iate	No	
Schnike 2010	513	10. 8	49	Black: 54% Hispanic: 30% White: 11%	Primary	n/a: 10 45 minute sessions; annual booster session	assessment only	7 years	Yes	● substance use- alcohol _ ● substance use - binge drinking _ ● substance use- cigarettes ● substance use- marijuana ● refusal skills- alcohol + ● intentions- alcohol
CD-ROM + Computer Program										
Schnike & Schwin n 2005	91	n/a	0	Not reporte d	primary	Girls and Stress: 1 20-30 minute session	convention al drug abuse prevention program	2 weeks	No	● coping skills- stress reduction strategies + ● cognitions/attitudes- approval of alcohol _ ● cognitions/attitudes- approval of cigarettes _ ● cognitions/attitudes- approval of other drugs _ ● intentions- cigarettes _ ● intentions- alcohol _ ● intentions- marijuana _ ● intentions- other drugs

Website										
Schwin n 2015	23 6	16. 08	32.2	White: 62.1% Hispan ic: 13.3% Black: 9.7% Asian: 7.5% Czech: 62.9% Swedis h: 17.3% Germa n: 10.1% Flemis h: 9.9% White: 63% Black: 17% Hispan ic: 15% Asian: 4%	primary	n/a: 3 14 minute sessions	assessment only	3 months	yes	● refusal skills ● substance use- alcohol ● substance use- cigarette ● substance use- marijuana ● substance use- other drugs
Arnaud 2016	14 49	16. 8	51.8	White: 62.9% Swedis h: 17.3% Germa n: 10.1% Flemis h: 9.9% White: 63% Black: 17% Hispan ic: 15% Asian: 4%	secondar y	WISEteen: 1 15 minute intervention	assessment only	3 months	yes	● substance use- alcohol: _ ● substance use- drinking frequency: _ ● substance use- binge drinking frequency: _ ● substance use- drinking frequency ● substance use- illegal drug ● substance use- polydrug
Schwin n 2018	78 8	13. 7	0	White: 63% Black: 17% Hispan ic: 15% Asian: 4%	Primary	Realteen: 9 15-minute intervention sessions	assessment only	1 year	no	● substance use- cigarettes _ ● substance use- alcohol ● substance use- marijuana ● substance use- other drugs ● substance use- binge drinking _ ● refusal skills- +
Schwin n 2019	78 8	13. 7	0	White: 63% Black: 17% Hispan ic: 15% Asian: 4%	Primary	Realteen: 9 15-minute intervention sessions	assessment only	3 years	no	● substance use- cigarettes _ ● substance use- e-cigarettes _ ● substance use- alcohol ● substance use- marijuana ● substance use- other drugs ● substance use- binge drinking _ ● refusal skills + ● well-being- anxiety and perceived stress +
Vargas- Martinez 2019	12 47	16. 8	46.9	Spanish: 94.7% White: 85.2% Hispan ic: 4.8% Asian: 4.5% Black: 1.6% American Indian/ Alaska Native: 1.3% Spanish: 94.7%	primary	Alerta Alcohol: 6 sessions	assessment only	4 months	no	● substance use- binge drinking: _ ● well-being- quality of life
Doumas 2020	31 1	17. 15	44.4	Spanish: 94.7% White: 85.2% Hispan ic: 4.8% Asian: 4.5% Black: 1.6% American Indian/ Alaska Native: 1.3% Spanish: 94.7%	primary	eCHECKUP TO GO: 1 15 minute intervention	assessment only	3 months	no	● coping skills- protective behavioral strategies ● cognitions/attitudes- positive alcohol expectancies _ ● substance use- alcohol (females) _ ● substance use- alcohol (males) ● substance use- peak drinking _
Martinez-Montilla 2020	12 47	16. 8	46.9	Spanish: 94.7%	primary	Alerta Alcohol: 6 sessions	assessment only	4 months	yes	● substance use- binge drinking ● substance use- heavy episodic drinking

										● substance use- weekly consumption (alcohol) ● substance use- any consumption (alcohol)
Marsch 2021	406	15.8	29.6	White: 65.7% Asian: 17.3% Black: 8.8%	primary	POP4Teens : 8 30 minute sessions	educational website	6 months	yes	● cognitions/attitudes- negative opioid expectancies + ● cognitions/attitudes- positive opioid expectancies ● cognitions/attitudes- perceived risks of opioids ● knowledge- opioids + ● intentions- opioids

Website + SMS Texting

Haug 2017	1041	16.8	47.4	Swiss: 56.9%	primary	Mobile Coach Alcohol: 1 web-based session + 16-17 text messages	assessment only	6 months	yes	● substance use- risky occasion drinking _ ● substance use- peak blood alcohol concentration ● cognitions/attitudes: peer drinking norms
Mello 2019	36	15.6	78	White: 62% Black: 5.4%	secondary	Parenting Wisely: 4 web-based sessions + 24 text messages	standard care	6 months	no	● substance use- alcohol ● substance use- marijuana

Website + App (Game)

Parisod 2018	151	11	47.4	Not reported	primary	“Fume”: 20 min training session + 2 weeks unlimited usage	assessment only	2 weeks	yes	● refusal skills- anti-smoking self efficacy ● cognitions/attitudes- smoking outcome expectations ● cognitions/attitudes- attitudes toward tobacco use ● cognitions/attitudes- motivation to decline tobacco ● knowledge- tobacco
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Computer Program

Bryson 1999	182	n/a	48.3	overwhelming majority hispanic Black: 54.3% Caribbean American: 18.4% Hispanic: 17.9% Asian: 5.2%	primary	Refusal Challenges: 2 1 hour sessions	unrelated computer program	6 months	no	● refusal skills +
Schnike 2004	189	9.6	50		secondary	n/a: 1 20 minute session	assessment only	2 weeks	no	● adjustment- anger management + ● cognitions/attitudes- perceptions of people who use drugs _

Cunningham 2009	533	16.7	41.8	Black: 55% White: 37.2% Hispanic: 6.2%	secondary	SafER teens: 1 30 minute intervention	informational brochure	3 months	yes	● cognitions/attitudes- alcohol _ ● cognitions/attitudes- violence _ ● refusal skills- violence + ● refusal skills- alcohol ● cognitions/attitudes- readiness for change ● knowledge- alcohol + ● knowledge- cannabis + ● substance use- alcohol _ ● substance use- marijuana _ ● cognitions/attitudes- alcohol expectations ● cognitions/attitudes-cannabis ● caregiver relationship-communication + ● caregiver relationship-family rules ● coping skills- stress + ● well-being - depression ● refusal skills- + ● substance use- alcohol _ ● substance use- marijuana _ ● substance use- prescription drug misuse _ ● substance use- cigarettes ● intentions- substances _
Newton 2009	764	13.08	60	Not reported	primary	Climate Schools: Alcohol and Cannabis: 12 40 minute sessions	standard health education	6 months	no	
Schnike 2009	916	12.76	0	Black: 40.6% White: 23.2% Hispanic: 23.1% Asian: 10.8%	primary	n/a: 9 45 minute sessions	assessment only	2 years	no	● knowledge- alcohol + ● substance use- weekly alcohol consumption (females) _ ● substance use- weekly alcohol consumption (males) ● substance use- binge drinking (females) _ ● substance use- binge drinking (males) ● consequences- alcohol harms (females) _ ● consequences- alcohol harms (males) ● cognitions/attitudes- alcohol related expectancies _
Vogl 2009	1466	13	59	Not reported	primary	Climate Alcohol Program: six 40 minute sessions	teacher content only- no computerized intervention	1 year	yes	
Velicer 2013	4,158	11.4	52.2	White: 65% Hispanic: 15.6% Black: 3.8% Asian: 2.4% American Indian/ Alaskan Native: 2.2%	primary	Substance Prevention Intervention : five 30 minute sessions	energy balance intervention: targeting exercise, diet and TV viewing.	3 years	no	● substance use- alcohol ● substance use- smoking

Walton 2013	71 4	14. 9	43	Black: 63.7% Hispanic: 9.2%	primary	Computer Brief Intervention : 1 30 minute session	informatio nal brochure	1 year	no	● substance use- cannabis _ ● substance use- other
Vogl 2014	17 34	15. 44	66.2	Not reporte d	primary	Climate Schools Psychostim ulant and Cannabis Module: six 40 minute sessions	standard health education	10 months	yes	● knowledge- cannabis + ● knowledge- psychostimulants + ● cognitions/attitudes- cannabis + ● cognitions/attitudes- psychostimulants + ● substance use- cannabis, meth/amphetamine, ecstasy ● intentions- cannabis, meth/aphetamine and ecstasy
Brick 2017	4,1 58	11. 4	52.2	White: 65% Hispanic: 15.6% Black: 3.8% Asian: 2.4% American Indian/ Alaska n Native: 2.2%	primary	Substance Prevention Intervention : five 30 minute sessions	energy balance interventio n: targeting exercise, diet and TV viewing.	3 years	no	● substance use- alcohol ● substance use- smoking
Ismayai lova 2018	18 1	15. 27	61.3 3	Russia n: 48.1% Kazakh : 27.6%	secondar y	Kazakhstan i Family Together: 3 30 minute sessions	standard health education	6 months	no	● adjustment- temper outbursts _ ● refusal skills- peer pressure _ ● substance use- binge drinking _ ● cognitions/attitudes- approving substance use ● intentions- substance use
Ismayai lova 2018	18 1	15. 27	61.3 3	Russia n: 48.1% Kazakh : 27.6%	secondar y	Kazakhstan i Family Together: 3 30 minute sessions	standard health education	6 months	no	● caregiver relationship- positive parenting + ● caregiver relationship- corporal punishment _ ● caregiver relationship- supervision + ● caregiver relationship- risk behavior communication ● caregiver relationship- closeness (males) +
Griffin 2022	14 47	11. 94	48.3	White: 67.4% Black: 16.8% Hispanic: 12.2%	primary	Life Skills program: 14 7 minute intervention s + six 40 minute person class sections	standard health education	3 months	no	● substance use- cigarettes ● substance use- e-cigarette _ ● substance use- alcohol ● substance use- drunkenness _ ● substance use- marijuana ● substance use- prescription drug misuse

Native
American:
4.1%
Asian:
2.8%

- knowledge- smoking +
- knowledge- alcohol +
- knowledge- marijuana +
- knowledge- prescription drug misuse +
- knowledge- skills +

Computer Program + Website + App

Champion 2023	9280	12.7	49.9	Not reported	primary	Health4life: six 20 minute web-interventions + additional 7 25 minute modules on app/website	standard health education	2 years	yes	● substance use- alcohol ● substance use- smoking ● knowledge- chronic disease risk factors: +
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SMS texting

Mason 2021	69	15.2	33	White: 76.8% Hispanic: 8.7% Black: 7.2%	primary	Peer Network Counseling-Text (PNC text): 14 texts over 4 weeks	wait-list	3 months	no	● well-being- depression _ ● well-being- anxiety _ ● caregiver relationship ● substance use ● substance use- odds of a positive drug test _
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App

DeLuca 2020	884	15.1	49	White: 62.5%	primary	SIPS city: unlimited access for 12 months	assessment only	1 year	yes	● substance use- alcohol ● adjustment - emotional symptoms ● adjustment - conduct problems ● adjustment - hyperactivity ● adjustment - peer problems ● adjustment - prosocial behavior
DeLuca 2020	756	16.1	49.8	White: 85.9%	secondary	SIPS city: unlimited access for 12 months	standard care	1 year	yes	● substance use- alcohol ● adjustment - emotional symptoms ● adjustment - conduct problems ● adjustment - hyperactivity ● adjustment - peer problems ● adjustment - prosocial behavior ● substance use- polydrug use _
Schwinn 2021	678	14.1	40	Hispanic: 100%	primary	Vamos: 10 15 minute sessions	assessment only	3 years	no	● substance use- marijuana _ ● substance use- alcohol ● refusal skills- self efficacy + ● refusal skills- marijuana + ● refusal skills- alcohol ● refusal skills- tobacco ● well-being- depression ● well-being- anxiety

App + SMS Texting

Haug 2020	63 3	17. 1	51.5	Swiss: 52.9%	secondary	Just-In-Time Planning Intervention : 10-20 texts	assessment only	immediate	yes	● substance use- alcohol: _ ● substance use- binge drinking
Haug 2021	1,4 73	15. 4	44.8	Swiss: 47.4%	primary	Smart Coach: 1-2 texts over 22 weeks	assessment only	6 months	no	● substance use- problem drinking ● substance use- tobacco smoking ● substance use- marijuana ● substance use- quantity of alcohol consumed_ ● well-being- reported stress_ ● adjustment- social skills
App (Game)										
Jander 2016	24 69	16. 3	52.7	Dutch: 88.4% Non-D utch: 11.6%	primary	Alcohol Alert: 3 sessions	assessment only	4 months	yes	● substance use- binge drinking (15-16)_ ● substance use- binge drinking: (17-18) ● substance use- excessive drinking ● substance use- weekly consumption
Social Media										
Epstein 2019	10 3	n/a	n/a	White: 88.3% Native American: 8.7% Hispanic: 6.8% Asian: 2.3%	primary	Facebook Group: 15 posts + 2 live q&a sessions	program only	6 months	yes	● caregiver relationship- bonding ● caregiver relationship- monitoring ● caregiver relationship - family conflict ● caregiver relationship- rules ● cognitions/attitudes: attitudes about marijuana

Author/Date	Selection Bias	Study Design	Confounders	Blinding	Data Collection Methods	Withdrawals and Dropouts	Global Rating
CD ROM							
Duncan 2000	Weak	Strong	Weak	Moderate	Weak	Strong	Weak
Williams 2005	Weak	Strong	Strong	Moderate	Strong	Strong	Moderate
Schnike 2006	Weak	Strong	Strong	Moderate	Moderate	Weak	Weak
Mathews 2007	Weak	Strong	Strong	Moderate	Moderate	Strong	Moderate
Schnike 2010	Weak	Strong	Strong	Moderate	Moderate	Strong	Moderate
CD-ROM + Computer Program							
Schnike & Schwinn 2005	Moderate	Strong	Strong	Moderate	Moderate	Weak	Moderate
Website							
Schwinn 2015	Weak	Strong	Strong	Moderate	Weak	Strong	Weak
Arnaud 2016	Moderate	Strong	Strong	Moderate	Moderate	Weak	Moderate
Schwinn 2018	Weak	Strong	Strong	Moderate	Strong	Moderate	Moderate
Schwinn 2019	Weak	Strong	Strong	Moderate	Strong	Moderate	Moderate
Vargas-Martinez 2019	Weak	Strong	Strong	Moderate	Strong	Weak	Weak
Doumas 2020	Weak	Strong	Strong	Moderate	Moderate	Strong	Moderate
Martinez-Montilla 2020	Weak	Strong	Strong	Moderate	Moderate	Weak	Weak
Marsch 2021	Weak	Strong	Strong	Weak	Moderate	Moderate	Weak
Website + SMS Texting							
Haug 2017	Moderate	Strong	Strong	Moderate	Moderate	Strong	Strong
Mello 2019	Weak	Strong	Strong	Moderate	Strong	Moderate	Moderate
Website + App (Game)							
Parisod 2018	Weak	Strong	Strong	Moderate	Strong	Strong	Moderate
Computer Program							

Epstein 2019	Moderate	Strong	Strong	Moderate	Strong	Strong	Strong
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