

# World Journal of *Psychiatry*

*World J Psychiatry* 2023 July 19; 13(7): 402-494



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**RESPONSIBLE EDITORS FOR THIS ISSUE**

Production Editor: *Yu-Xi Chen*; Production Department Director: *Xu Guo*; Editorial Office Director: *Jia-Ping Yan*.

**NAME OF JOURNAL**

*World Journal of Psychiatry*

**ISSN**

ISSN 2220-3206 (online)

**LAUNCH DATE**

December 31, 2011

**FREQUENCY**

Monthly

**EDITORS-IN-CHIEF**

Rajesh R Tampi, Ting-Shao Zhu, Panteleimon Giannakopoulos

**EDITORIAL BOARD MEMBERS**

<https://www.wjgnet.com/2220-3206/editorialboard.htm>

**PUBLICATION DATE**

July 19, 2023

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**PUBLICATION ETHICS**

<https://www.wjgnet.com/bpg/GerInfo/288>

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<https://www.wjgnet.com/bpg/gerinfo/208>

**ARTICLE PROCESSING CHARGE**

<https://www.wjgnet.com/bpg/gerinfo/242>

**STEPS FOR SUBMITTING MANUSCRIPTS**

<https://www.wjgnet.com/bpg/GerInfo/239>

**ONLINE SUBMISSION**

<https://www.f6publishing.com>



## Delivering substance use prevention interventions for adolescents in educational settings: A scoping review

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**Specialty type:** Psychiatry

**Provenance and peer review:**

Invited article; Externally peer reviewed.

**Peer-review model:** Single blind

**Peer-review report's scientific quality classification**

Grade A (Excellent): 0  
Grade B (Very good): 0  
Grade C (Good): C, C, C  
Grade D (Fair): 0  
Grade E (Poor): 0

**P-Reviewer:** Naseef PP, India;  
Rakhshan V, Iran; Saha L, India

**Received:** March 29, 2023

**Peer-review started:** March 29, 2023

**First decision:** May 19, 2023

**Revised:** May 26, 2023

**Accepted:** June 12, 2023

**Article in press:** June 12, 2023

**Published online:** July 19, 2023



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### Abstract

Currently, a proportion of adolescents use alcohol, tobacco, and illicit drugs, which inevitably harms their health and academic progress. Adolescence is a peak period for substance use initiation and a critical time for preventing substance use problems. Various entities, such as families, schools, and communities, have implemented a variety of interventions to alleviate adolescent substance use problems, and schools play a unique role. To explore the types, characteristics, and effectiveness of substance use interventions in educational settings for adolescents, we conducted a scoping review and identified 32 studies after screening. We divided the 32 studies according to intervention type, including curriculum interventions focusing on cognitive-behavioral skill enhancement, exercise interventions, peer interventions and family-school cooperation, and electronic interventions. Except for the mixed results on electronic interventions, the results showed that the other interventions were beneficial to different extents in alleviating adolescent substance use problems. In addition, we analyzed and summarized the advantages and challenges of intervening in adolescent substance use in educational settings. Schools can use equipment and human resources to provide adolescents with various types of intervention measures, but they also face challenges such as stigmatization, ineffective coordination among multiple resources, and poor implementation effects. In the future, school-based intervention measures can fully utilize big data and artificial intelligence technology and collaborate with families and communities to intervene appropriately while paying attention to the comorbidity risks of substance use disorders and psychological health issues.

**Key Words:** Substance use; Prevention; Adolescents; Educational settings; Artificial intelligence; Digital interventions

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**Core Tip:** Interventions in educational settings include curriculum interventions, physical activity interventions, peer interventions and family-school cooperation, and electronic interventions. Except for the mixed effectiveness of electronic interventions, all other intervention measures are beneficial in alleviating substance use problems among adolescents. Schools can utilize equipment and human resources to provide various types of interventions but also face challenges such as stigmatization and ineffective coordination between multiple resources. In the future, schools can fully utilize big data and artificial intelligence technologies, jointly intervene with families and communities, and appropriately address the comorbidity risks of substance use disorders and mental health issues.

**Citation:** Liu XQ, Guo YX, Wang X. Delivering substance use prevention interventions for adolescents in educational settings: A scoping review. *World J Psychiatry* 2023; 13(7): 409-422

**URL:** <https://www.wjgnet.com/2220-3206/full/v13/i7/409.htm>

**DOI:** <https://dx.doi.org/10.5498/wjpv13.i7.409>

## INTRODUCTION

Currently, substance use and abuse among adolescents have become important global public health issues. Adolescence is a critical period for physical and psychological development, as well as for experiencing life, pursuing independence, and establishing intimate relationships[1]. Individuals are more susceptible to substance use risks in the adolescent stage than in other stages of life. Research has shown that adolescence is the peak time for the initiation of drug use[2]. The level and frequency of drug use among adolescents begin to increase in mid-adolescence and peak in early adulthood. The median age of onset of alcohol use in most countries is 16-19 years[3]. The global burden of disease study showed that drug use is a significant factor in the health burden in the adolescent and young adult population[4]. Early exposure to alcohol, tobacco, and other drugs may lead to violent or aggressive behavior in adolescents, making it difficult for them to adapt to school, family, and social environments[5]. Such exposure not only causes various negative health outcomes [1], but may also result in psychological health issues such as anxiety and depression in adolescents[6-9]. Therefore, it is essential to identify substance use problems in the adolescent population as early as possible and to take timely intervention measures.

Multiple research results indicate that adolescent substance use problems are the result of the combined action of various risk factors, such as personal, family, school, community, and societal factors. Substance use by parents or relatives in the family environment has an insidious influence on adolescents while also providing a channel for their substance exposure[10]. Adolescents who are in disadvantageous positions in life are more likely to use drugs to escape the pressure of reality[11]. Peer substance use in the school environment may stimulate the curiosity of adolescents or cause them to use drugs to fit in due to “peer pressure”[12]. Implementing intervention plans based on different subjects is an effective strategy to address adolescent substance use problems[13-16]. First, at the social level, clearly defining the scope of legal substance use and adopting strict regulatory measures can effectively reduce adolescents’ negative substance use behavior[17]. For example, alcohol or tobacco price controls can be implemented through taxes[18-22], minimum age laws can be enforced[23], and the availability of inhalants can be minimized[24]. Second, at the family level, factors such as parenting style, family relationships, and family function can significantly predict adolescent drug abuse and related behaviors[25]. Family involvement has been found to be effective in treating adolescent substance use disorders. The basic principle of family-based intervention measures is to directly or indirectly establish more stable family relationships by providing training courses or developing intervention plans for parents and adolescents, thereby reducing the risk of adolescent substance use disorders[26-28]. For example, the Strong African American Families-Teen program effectively prevents drug use and emotional problems in black adolescents by offering 10 h of adolescent skills training courses and family courses[29]. Family matters (FM) helps parents identify family characteristics, behaviors, and attitudes that may affect adolescent drug use by regularly mailing families guidance manuals. Professional health education workers follow up on the use of the manuals by contacting parents after each mailing. The results of a study on FM showed that the complete intervention plans effectively reduced the rates of tobacco and alcohol use in adolescents [13]. Third, at the community level, some studies suggest that the community and its surrounding environment can play a positive role in adolescent substance use problems[16,30]. Community-based intervention plans usually require community leaders, community workers, and other stakeholders and professionals to work together. For example, in the Community Trials Intervention to Reduce High-Risk Drinking, community leaders use local policies and regulations to control the number of bars, retailers avoid selling alcohol to minors, and so on[13]. Clearly, intervention measures based on multiple stakeholders, such as those at the social, family, community, and school levels, can play an essential role in resolving adolescent substance use problems[16]. Multidimensional family therapy (MDFT) integrates family therapy, individual therapy, and drug counseling with multisystem intervention methods[31]. Multiple experiments have shown that MDFT is a more effective treatment method than other methods for adolescent drug abuse and comorbid mental symptoms[32].

In addition, as current adolescents are “digital natives”, they have a “natural” attraction to digital interventions[33-35]. Technology-based intervention measures are mainly interactive digital activities aimed at preventing or delaying adolescent drug use from the aspects of knowledge, attitude, and behavior[36-38]. RealTeen is a web-based intervention measure that places youth in realistic drug use scenarios by using interactive skills-building sessions. Adolescents can



improve their self-awareness and social skills, thereby avoiding drug use[39,40]. Studies have shown that after intervention, participants have lower rates of use of alcohol, marijuana, and multiple drugs[39]. Specific intervention measures based on multiple subjects are shown in Table 1.

Compared with other context, such as families and communities, the educational environment in schools offers unique advantages for intervening in adolescent substance use. Considering the characteristics of adolescence, such as a long duration of schooling, close peer interaction, and intensive education, schools are an excellent place to intervene in adolescent substance use[1]. On the one hand, school can educate adolescents on the characteristics and harms of the use of substances, such as alcohol, tobacco, and illegal drugs, by offering relevant courses. On the other hand, peer interaction and practical activities in the school environment can make adolescents value education, help them form a correct attitude toward life, and prevent substance use problems before they happen[41,42].

Recent research has focused on the importance of schools in addressing adolescent substance use problems and exploring effective intervention measures from different perspectives. For example, intervention models have been constructed based on cultural backgrounds and family relationships, Botvin Life Skills Training has been used to train students in the school environment, and psychological training has been implemented to prevent substance use problems among adolescents. These measures aim to improve adolescent tobacco use problems[43-45].

The existing literature has proposed various intervention measures based on the seriousness of adolescent substance use problems. However, the vast majority of research only discusses school-based intervention as one of many intervention measures[46], and few studies have directly investigated preventive intervention measures for adolescent substance use from the perspective of the educational environment. Considering the changes in adolescent substance use problems before and after the pandemic, this paper, based on a comprehensive review of existing literature in this field, focuses on research results from the past seven years and further explores preventive intervention measures for adolescent substance use in the educational environment.

## Objectives

Based on the unique advantages of schools in intervening with adolescent substance use and the richness of research in this field, we conducted a scoping review to understand specific intervention measures and their effectiveness in the current educational environment. Our research questions were as follows: (1) What are the intervention measures currently used in the educational environment to intervene with adolescent substance use? and (2) what are the characteristics and effects of these intervention measures?

## LITERATURE REVIEW

### Search strategy

To explore the types, characteristics, and effectiveness of intervention measures for adolescent substance use in the educational environment, we conducted a preliminary evaluation of relevant literature in this field. Literature searches were conducted in May 2023 in five databases: Web of Science Core Collection, PubMed, EBSCO, Scopus, and Google Scholar (selecting the top 200 most relevant articles). The following keywords and terms were used: (1) Substance use; (2) adolescent; (3) educational setting; and (4) prevention. The following string was used: ("substance use" [All Fields] OR "alcohol" [All Fields] OR "tobacco" [All Fields] OR "marijuana" [All Fields] OR ("illicit drug" [All Fields]) AND ("youth" [All Fields] OR "teenager" [All Fields] OR "adolescence" [All Fields]) AND ("school" [All Fields] OR "educational setting" [All Fields]) AND ("intervention" [All Fields] OR "prevention" [All Fields]).

### Study selection

The full screening process included three stages: (1) EndNote software was used to identify duplicate articles and retain those with more comprehensive information; (2) the first round of screening was conducted based on the inclusion and exclusion criteria, along with titles, abstracts, and keywords in EndNote; and (3) manual screening was performed based on the full text using Rayyan.

The inclusion criteria were as follows: (1) The age of the study subjects was 10-19 years (according to UNICEF, WHO, and UN Population Fund); (2) intervention measures were based in educational settings; (3) there was a specific, clear, and operational intervention plan for substance use problems; (4) the article was easily accessible; and (5) the article was published in English.

The exclusion criteria were as follows: (1) The age of the study subjects was outside the defined range; (2) intervention measures were based on other environments, such as family and community; (3) the article did not belong to the substance use problem category or only mentioned the topic briefly; (4) the article was a literature review, letter to the editor, or opinion piece; (5) the article was from the gray literature; and (6) the article was published in a language other than English. Please see Figure 1 for the specific screening process.

### Data analysis

After screening, a total of 32 articles were obtained. Analyses and table summaries of the literature revealed that these articles could be grouped based on the type of intervention strategies used. The two primary themes and their associated subthemes are as follows: (1) Various types of intervention strategies and their effects include interventions that focus on cognitive-behavioral skill building, exercise, peer and family involvement, and electronic interventions; and (2) differences in substance use intervention strategies among adolescents in different educational stages.

**Table 1 Multiagent-based adolescent substance use interventions**

Implementation subject	Intervention method	Specific measures
Based on social intervention measures	Clarifying the scope of legal substance use and adopting strict regulatory measures	Manage the age, sales timeframe, permissible quantities, and pricing of substances and regulate users[18]
		Levy taxes on the alcohol or tobacco content of goods and tie them to fluctuations in consumer pricing[19]
		Implement and enforce laws mandating a minimum age limit and raise the age threshold for young people to purchase alcoholic beverages[18,23]
Based on family intervention measures	Providing training courses for parents and teenagers	Create community-specific regulations concerning the issuance of tobacco and alcohol licenses to minors and promote their enforcement within localities[24]
		Strong African American Families-Teen program: Deliver skill-building courses and family training sessions spanning 10 h and comprising 5 sessions to both parents and teenagers[29]
	Developing intervention plans	Creating lasting family connections: Offer a 20-wk facilitator training program for parents and teenagers[13]
		Families preparing the new generation plus: Execute a 10-wk prevention plan for nutrition and material use while emphasizing healthy eating and parenting strategies[26]
Based on community intervention measures	Providing community intervention programs	Familias Unidas: Enforce a set of intervention measures aimed at enhancing parents' sense of efficacy and parenting skills (parent support networks), family meetings/home visits, parent-adolescent discussion circles, adolescent activity groups, supervised peer activities, and school counselor meetings[27]
		Risk reduction therapy for adolescents: Intervention measures conducted by a professional therapist with a relevant master's degree at an outpatient clinic. Caregivers are obligated to attend a weekly session lasting between 60 min and 90 min[28]
Based on technology intervention measures	Utilizing innovative intervention methods, such as the internet and big data	Community trials intervention to reduce high-risk drinking: To modify the community's drinking behavior, offer responsible beverage service, reinforce law enforcement, and set up alcohol checkpoints[13]
		Deliver a 10-wk intervention plan for adolescents using the Health Rocks program and multiple disciplinary literacy strategies. Emphasize the effects of substance abuse on health and require adolescents to attend a one-hour theme-based instruction per week[30]
Based on technology intervention measures	Utilizing innovative intervention methods, such as the internet and big data	CLIMATE: Provide 6 lessons based primarily on social influence theories <i>via</i> CD-ROM and the Web. The lessons provide knowledge about how common substance use is as well as the negative outcomes it can lead to and teach methods to avoid substance use and the subsequent hazards[37]
		HeadOn: Require the involvement of students in decision-making related to substance use through interactive simulation scenarios[38]

## LITERATURE RESULTS

Each section summarizes the mechanism and effects of various intervention measures (Tables 2-5).

### **Various types of intervention measures and their effects**

**Curriculum interventions focused on cognitive-behavioral skill enhancement**[47,48]: The mechanism of these interventions involved two parts (Table 2): (1) Using traditional ethnic values and methods to prevent smoking, drug use, *etc.*[49] and connecting the psychological and social concepts of substance use with multicultural values[50] to regulate adolescent substance use behavior; and (2) implementing a series of courses to improve students' cognitive and behavioral skills[51], including knowledge about the characteristics and harms of alcohol, tobacco, and illicit drugs[52], communication[53], decision-making and other life skills[54,55], and methods to resist drug use pressure[56,57]. These interventions had positive effects on adolescent alcohol, cigarette, and marijuana use to varying degrees. A study conducted a randomized field trial with seventh- and ninth-grade students to implement a school-based intervention program, Take Charge of Your Life (TCYL), to prevent adolescent alcohol, tobacco, and drug use. The TCYL program follows the principles of substance abuse prevention programs, using counseling classes to help students understand the negative effects of alcohol, tobacco, and illicit drugs on individuals and society, and it requires students to learn communication, decision-making, assertiveness, and refusal skills. The results of the study showed that TCYL helped reduce the potential motivation for drug use and was beneficial for students who smoked marijuana[58] (Table 2).

**Exercise interventions:** Exercise is one of many health behaviors associated with good lifestyle habits[59]. Exercise programs to intervene in adolescent substance use problems help adolescents develop good lifestyle habits to reduce the willingness to engage in substance use and the frequency of substance use[60,61]. Werch *et al*[62] and Goldberg *et al*[63] primarily used exercise screening, counseling, and exercise training courses to reduce adolescent drinking behavior and improve health habits. More recently, new forms of exercise intervention have emerged in schools. Some examples

Table 2 Curriculum interventions focusing on cognitive-behavioral skill enhancement

Ref.	Age/gender	Scope of application			Method	Content	Effect	Location
		Alcohol	Tobacco	Illicit drugs				
Diaz Gomez <i>et al</i> [47], 2021	10-12 yr, all genders	Yes	Yes	-	Randomized controlled cluster study	Primavera is a prevention program that focuses on experiences and involves multiple modes of delivery. It spans several years and has a generic approach	Primavera is effective in decreasing alcohol consumption among school students	France
Kimber <i>et al</i> [48], 2009	Grades 7 to 9 (13-16 yrs), all genders	Yes	Yes	Yes	Nonrandomized five-year longitudinal design	Teachers offer weekly lessons on social and emotional training to students	A particular group of people derived benefits from the program	Sweden
Hecht <i>et al</i> [49], 2003	Grade 7, all genders	Yes	Yes	Yes	Randomized controlled trial	Interventions based on culture are conducted through 10 specific lessons and a media campaign utilizing a model of cultural resilience	The intervention had a considerable and noteworthy effect on individual consumption of alcohol, cigarettes, and cannabis	United States
Unger <i>et al</i> [50], 2004	Grade 6, all genders	-	Yes	-	Participatory research	The Project Fun Learning About Vitality, Origins, and Respect is a curriculum that promotes multicultural education	The project successfully stopped hispanic boys from starting smoking but had no impact on other groups	United States
Walker <i>et al</i> [51], 2011	14-19 yr (Grade 9-12), all genders	-	-	Yes	Randomized controlled trial	Motivational enhancement therapy, educational feedback control, and delayed feedback control	Participants stated that they used cannabis less frequently and experienced fewer negative outcomes	United States
Faggiano <i>et al</i> [52], 2010	12-14 yr, all genders	Yes	Yes	Yes	Cluster randomized controlled trial	The program involved a 12-h curriculum that was developed using a thorough social influence approach	Alcohol abuse and marijuana use showed a consistent improvement, whereas smoking displayed no change	Spain, Belgium, Germany, Sweden, Greece, Italy, and Austria
Dent <i>et al</i> [53], 2001	14-17 yr, all genders	Yes	Yes	Yes	Randomized controlled trial	Project Toward No Drug Abuse: Standard care and classroom education program	Over a period of one year after the program, this population saw statistically significant changes in alcohol and illicit drug use	United States
Hanewink <i>et al</i> [54], 2004	Grades 5 and 6 (mean age 11.4 yr), all genders	-	Yes	-	Randomized controlled trial	The smoking prevention program utilized a life-skills approach and included 21 sessions	The program did not have a distinct impact on the current smoking rate (percentage of people who smoked in the past 4 wk)	Austria, Denmark, Luxembourg, and Germany
Botvin <i>et al</i> [55], 2001	Grades 7 to 9, all genders	Yes	-	-	Randomized controlled trial	A proactive approach that educates individuals on resisting alcohol and drug consumption, promoting healthy social norms, and providing material to encourage personal and social skill-building	The prevention program was effective in protecting against episodes of excessive drinking	United States
Botvin <i>et al</i> [56], 1999	Grade 7 (mean age 12.9 yr), girls	-	Yes	-	Randomized controlled trial	This program consists of 15 sessions aimed at teaching social resistance skills within a broader initiative that aims to promote general personal and social competence skills	The number of urban minority girls who started smoking or increased their smoking habits was significantly reduced	United States
Shope <i>et al</i> [57], 1998	Grade 6 (mean age 12 yr), all genders	Yes	Yes	Yes	Participatory research	The students in the curriculum group were taught about alcohol, tobacco (including cigarettes and smokeless	The curriculum achieved short-term effectiveness by considerably decreasing the rising rates of alcohol	United States



						tobacco), marijuana, and cocaine	consumption and addiction, tobacco use, cocaine intake, and other types of substance abuse	
Sloboda <i>et al</i> [58], 2009	Between seventh and ninth grade, all genders	Yes	Yes	Yes	Randomized field trial	TCYL offers students essential life skills, which include communication, decision-making, assertiveness, and refusal skills	TCYL had a negative impact on students' use of alcohol and tobacco as a result of medical treatment	United States

TCYL: Take charge of your life.

**Table 3 Exercise interventions**

Ref.	Age/gender	Scope of application			Method	Content	Effect	Location
		Alcohol	Tobacco	Illicit drugs				
Werch <i>et al</i> [59], 2005	Ninth and eleventh grade, all genders	Yes	Yes	Yes	Randomized controlled trial	Project SPORT is a short intervention that promotes healthy habits by integrating physical activity and preventing alcohol use	After the treatment and after one year, it was anticipated that the project would have an impact on the drinking and smoking habits of adolescents	United States
Brick <i>et al</i> [60], 2017 and Velicer <i>et al</i> [61], 2013	Grade 6, all genders	Yes	Yes	-	Multiattribute utility measurement approach	An intervention aimed at preventing substance use and promoting a healthy energy balance through physical activity, consumption of fruits and vegetables, and decreasing sedentary behavior	The outcome of every action was a significant decrease in the prevalence of smoking and drinking compared to the existing rates reported by ninth-grade students	United States
Werch <i>et al</i> [62], 2003	Grade 8, all genders	Yes	-	-	Randomized experimental design	Consultation for Sports (Sport): A process of evaluating one's health and fitness followed by discussion and recommendations	The program may boost the frequency of physical activity while decreasing alcohol consumption	United States
Goldberg <i>et al</i> [63], 2000	Grade 9 and grade 10, all genders	Yes	-	Yes	Randomized controlled trial	An education program centered on team collaboration and designed for a specific gender, which includes interactive classroom sessions and exercise training	The program was successful in stopping people from using alcohol and other prohibited drugs	United States
Butzer <i>et al</i> [64], 2017	Grade 7 (with a mean age of 12.64), all genders	-	Yes	-	Preliminary group randomized controlled trial	The curriculum of Kripalu Yoga in the Schools has a version that includes 32 sessions	Practicing yoga in schools can be helpful in reducing the inclination of both males and females towards smoking	United States
Fishbein <i>et al</i> [65], 2016	Grades 9 to 12 (mean age 12 yr), all genders	Yes	-	-	Pilot randomized controlled trial	A 20-session mindfulness yoga program created for students at risk of dropping out from school	The students who took part in yoga sessions showed a reduction in alcohol consumption	United States
Mathews <i>et al</i> [66], 2007	High school students, all genders	Yes	Yes	Yes	Randomized controlled trial	The project SPORT comprises of a brief interactive CD-ROM and a brief group consultation	The project received considerable acceptance among adolescent males and females and could be effective	United States
Horn <i>et al</i> [67], 2013	14-19 yr, all genders	-	Yes	-	Randomized group trial	The physical activity levels of participants in a smoking cessation program for teenagers improved with the addition of a physical activity component	Adolescents in good health are more likely to decrease their amount of smoking	United States

include integrating yoga into students' physical education classes to reduce their smoking habits[64,65] and combining exercise with an interactive CD-ROM to tailor exercise plans for students to execute independently[66]. The results of these studies confirm that exercise interventions are acceptable to adolescents and help reduce substance use behavior.

**Table 4 Peer interventions and family-school cooperation**

Ref.	Age/gender	Scope of application			Method	Content	Effect	Location
		Alcohol	Tobacco	Illicit drugs				
Paquette <i>et al</i> [68], 2019	Ages 13-17, all genders	Yes	-	Yes	Randomized controlled trial	"Amplifying Our Futures (Amp)" is a temporary intervention program that consists of four phases. It is designed for adolescents who are at low to moderate risk of using substances and is facilitated by trained companions aged 18-28 years old	Young peer intervention was valuable in educational environments	United States
Botvin <i>et al</i> [69], 1990	Grade 7, all genders	Yes	Yes	Yes	Cluster randomized controlled trial	Life skills training is a program designed to improve cognitive and behavioral skills, which is led by both experienced students and teachers in a classroom setting for a total of 20 sessions	Preventative programs have had a quantifiable effect on behavior related to substance use	United States
Furr-Holden <i>et al</i> [70], 2004	Grades 1-8, all genders	Yes	Yes	Yes	Randomized prevention trial	The classroom-centered intervention and the family-school partnership intervention	Two interventions had a clear protective effect against tobacco use	United States
Zavela <i>et al</i> [71], 2004	Grades 4-8, all genders	Yes	Yes	Yes	Control experiments and follow-up questionnaire	Say Yes First-To Rural Youth and Family Alcohol/Drug Prevention: An educational and case management approach to drug prevention	The students who were part of the program consumed less alcohol, tobacco and other drugs and had a lower occurrence of marijuana use throughout their lifetime	United States
Winters <i>et al</i> [72], 2012	Ages 14-17, all genders	Yes	-	Yes	Randomized controlled trial	BIs: Therapists used the principle of motivational interviewing to conduct topical sessions with parents and students	BIs showed a connection with decreased drug usage, with a greater impact when parents were included	United States

Bis: Brief interventions.

Horn *et al*[67] combined physical activity and smoking cessation interventions for adolescents. The research suggested that students who increased their exercise time by 20 min were more likely to reduce their daily smoking quantity (Table 3).

**Peer and family-school interventions:** On the one hand, peer support is a protective factor for substance use problems in adolescents, and the role of peers can provide screening and intervention measures that are suitable for adolescent development[68]. Botvin *et al*[69] showed that peer intervention programs were more effective than regular classroom teaching. The Amplifying Our Futures program, jointly designed by multiple stakeholders such as schools, communities, and adolescents, is implemented by trained young adults. The results on the program confirmed the value of peers in substance use intervention in adolescents[68]. In addition, some research indicated that forming a partnership between families and schools, strengthening communication and exchange between the two parties, and effectively involving parents in adolescent substance use intervention can help reduce adolescents' early substance use behavior[70-72] (Table 4).

**Electronic interventions:** Currently, the application of electronic interventions in adolescent substance use is relatively limited. Examples include (1) Having teenagers watch videos and public service announcements[73] or teaching adolescents about alcohol, tobacco, and cannabis using electronic learning modules or programs[74,75]; (2) designing internet-based intervention plans for teenagers[76,77]; and (3) adopting alcohol media literacy programs to enhance teenagers' media literacy skills and reduce the potential impact of substance use-related advertisements on teenagers[78]. However, researchers have not yet reached a consensus on the effectiveness of electronic interventions. It is suggested that internet-based intervention plans are convenient for reducing alcohol and cannabis use, and research results showed that students in the intervention group reduced alcohol use one year after completing the course[76]. However, a web-based program called Consider This, implemented by Buller *et al*[77], was found to be of little value in preventing adolescent substance use (Table 5).

### **Differences in substance use intervention measures for adolescents at different educational stages**

Adolescence is a critical period for preventing substance use. Through a literature review and summary, we found that intervention measures for substance use among adolescents at different educational stages need to focus on different

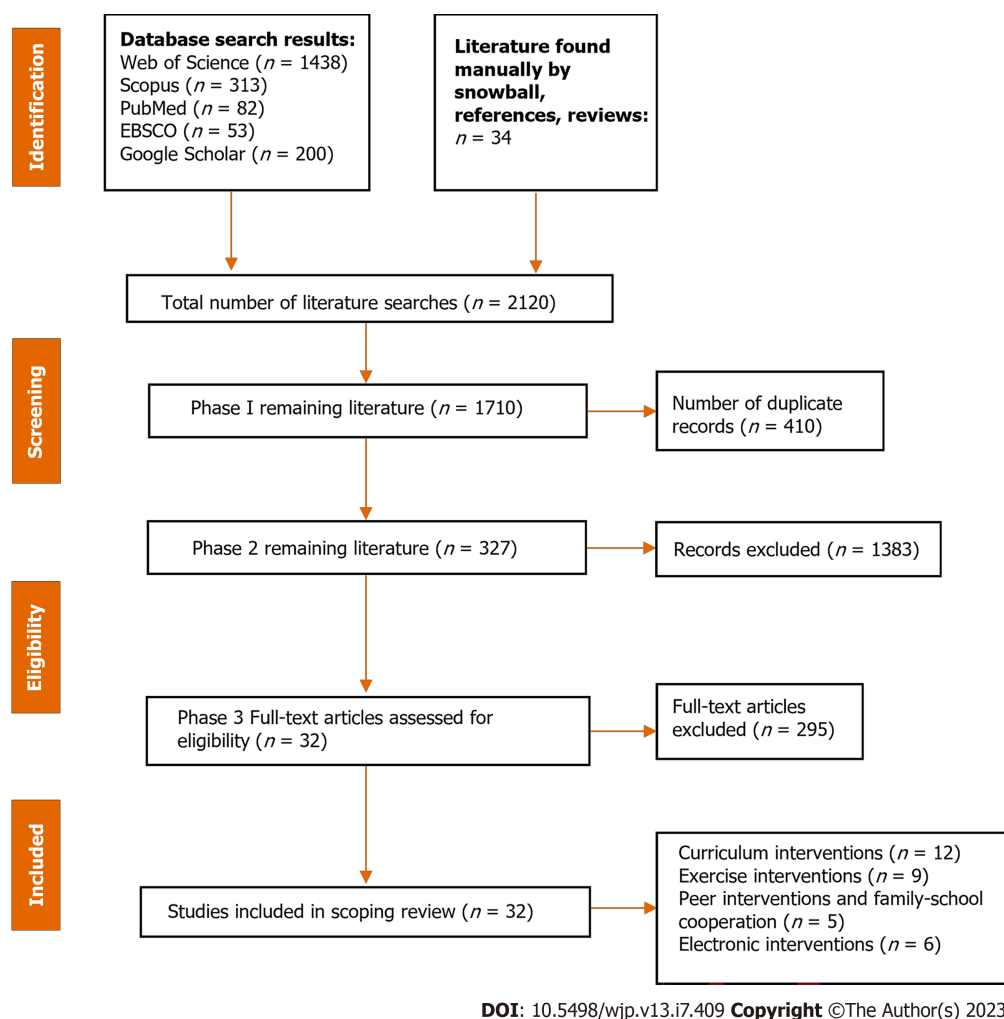
Table 5 Electronic interventions

Ref.	Age/gender	Scope of application			Method	Content	Effect	Location
		Alcohol	Tobacco	Illicit drugs				
Jennifer <i>et al</i> [73], 2006	Grade 7, all genders	Yes	Yes	Yes, marijuana	Randomized controlled trial	The usefulness of the Drug Resistance Strategies Project's Keepin' it REAL program aimed at preventing adolescent substance use was explored by studying students who participated in it through public service announcements and videotapes	Class videos influenced the use of drugs among teenagers, whereas PSAs did not have an impact	United States
Malmberg <i>et al</i> [74], 2014	11-15 yr, all genders	Yes	Yes	Yes	Randomized clustered trial	Healthy School and Drugs program: Digital modules for e-learning and comprehensive intervention	Both the e-learning and comprehensive intervention failed to prevent the initiation of alcohol, tobacco, or marijuana use	The Netherlands
Kiewik <i>et al</i> [75], 2017	12-16 yr, all genders	Yes	Yes	-	Pre-/post-intervention pilot study with a control group	"Prepared on time": A digital training program that follows the attitude-social influence-efficacy model	This research demonstrated that an electronic learning prevention program is feasible for teenagers with mild or moderate intellectual disability	The Netherlands
Newton <i>et al</i> [76], 2010	13 yr, grade 8, all genders	Yes	-	Yes	Cluster-randomized controlled trial	Internet-based prevention programs for school-age children: The Climate Schools: Alcohol and Cannabis course	After finishing the programs, students' understanding of alcohol and cannabis improved, and it also led to a decrease in the consumption of alcohol for up to twelve months	Australian
Buller <i>et al</i> [77], 2008	Grades 6 to 9, all genders	-	Yes	-	Randomized trials	Consider This: There were a total of 73 online activities divided into six modules: Introduction, media literacy, relationships, mind and body, decision making, and resistance strategies	The activities led to a decrease in smoking and/or a decrease in students' expectations of smoking in the future	Australia and United States
Gordon <i>et al</i> [78], 2017	9-12 yr, all genders	Yes	-	-	Qualitative assessment	Alcohol media literacy programs: Providing children with the necessary skills to question and critically evaluate the information they receive from media sources	Using culturally specific advertisements as a means to educate about the effects of alcohol proved to be a potent strategy	Australia

areas. One demonstration project on minimizing drug harm confirmed this view. In this project, a quasi-experimental intervention was conducted with middle school and high school students for four years. The results showed that education on minimizing drug harm was not suitable for middle school students[79]. We believe that this may be related to the developmental characteristics of adolescents at different educational stages. Adolescents in the upper grades of primary school and in the junior high school stage are in a semimature state and are more prone to imitate behaviors such as smoking and drinking due to curiosity or a psychological desire for conformity. Therefore, at this stage, interventions should focus on guiding adolescents' behavior and values. High school students are relatively mature and have higher levels of cognition and behavioral abilities. Some students in this group may already have varying degrees of substance use disorders. Therefore, interventions should focus on consolidating awareness education and preventing increase substance use.

### Advantages and challenges of substance use interventions for adolescents in educational environments

**Advantages:** Educational environments provide convenient spaces for intervening in substance use among adolescents. The advantages can be summarized in the following five aspects. First, school environments are the context of various interpersonal relationships, including those involving peers, teachers, and administrative personnel. Support from interpersonal relationships is a protective factor against adolescent substance use[80]. Intervention plans for the school context can combine the strengths of multiple stakeholders and maintain a high level of interaction among participants [73]. Examples include peer group pressure interventions[81] and family-school cooperation interventions[70]. Second, schools have unique advantages in terms of facilities and human resources. Evidence suggests that collective interventions are effective in treating adolescent mental health problems and substance use disorders[82]. Schools are



**Figure 1 Literature screening process.**

ideal places to conduct collective interventions. Teachers can use the school's basic equipment and multimedia devices to conduct general courses to prevent substance use disorders, teach students about the potential risks of substance use, and enhance their decision-making and drug refusal abilities[82]. Third, many behaviors of adolescents, including substance use, are related to their experiences in school. Therefore, intervention plans for the school context can change the external environment to which adolescents are exposed and have external validity[72]. Fourth, it is easy to conduct large-scale screening for substance use in educational environments. Effective early screening for substance use problems is essential for preventing or delaying the use of alcohol, tobacco, and illegal drugs during the vulnerable period of adolescent substance use problems. Schools can use standard screening tools to screen students regularly and universally to identify potential substance use problems as early as possible and implement targeted interventions in a timely manner. Fifth, research shows that there may be a mechanism of mutual influence between students' mental health problems such as anxiety and depression and their substance use behaviors[6,7]. These problems are not conducive to the healthy growth and academic progress of adolescents. Schools provide a favorable environment for addressing these issues. Intervention measures in the school context can alleviate the substance use behavior of at-risk groups, promote the physical and mental health and academic performance of students, and create a virtuous circle, benefiting more adolescents.

**Challenges:** There is no doubt that education settings face many challenges in providing effective substance use interventions for adolescents. First, intervening with students who already have substance use disorders in schools can potentially compromise their privacy, leading to stigmatization risks. When students are afraid of being labeled as having "drug use problems" and refuse school intervention measures, the work becomes difficult[72]. Second, school-based intervention programs often require approval from the school board and coordination among multiple departments. However, considering the school's image, the board may deny the existence of substance use problems at different levels in the school to avoid affecting its enrollment and future development[83]. In addition, it is difficult for multiple departments to reach a consensus on the design and implementation of an intervention plan, and there may be complex problems such as misunderstandings and slow progress during the implementation process. Third, providing substance use-related courses for adolescents undoubtedly increases the burden and pressure on teachers and administrators, perhaps because they need to receive training from professionals in advance and spend much time and energy on teaching. Teachers and administrators also bear pressure from their own teaching tasks and other administrative work,

which may lead to role conflict and role overload[84]. Therefore, schools may need to provide necessary incentives for the implementers of intervention plans to increase their motivation. Fourth, the school environment increases the availability of alcohol, tobacco, and illegal drugs. In a 2009 study on adolescent risk behavior, 23% of students reported being offered drugs in school[82]. This indicates that in addition to actively formulating intervention plans, schools still need to build a positive, environmentally friendly, and healthy campus environment to prevent the spread of the use of alcohol, tobacco, and illegal drugs in schools. Fifth, as “digital natives”, adolescents have a higher acceptance of electronic interventions than older age groups. However, the effectiveness of electronic interventions for adolescents with substance use disorders is not ideal. In the context of rapid informatization, fully tapping the potential of internet interventions and further introducing digital intervention in educational settings remains a challenge for school health workers and researchers.

## DISCUSSION

In the face of the public health challenges posed by adolescent substance use and abuse, schools have an important mission as ideal places to implement intervention plans. In addition to carrying out regular substance use screening and implementing intervention plans according to different categories (such as universal intervention measures for all students, selective intervention measures for students at high risk of substance use, and directive intervention measures for students with substance use disorders), in the future, school-based intervention measures can focus on introducing big data and artificial intelligence technology; integrating advantageous resources from families, schools, and communities; and combining psychological health interventions.

Fully utilizing big data and artificial intelligence technology. In recent years, with the rapid development of artificial intelligence, machine learning, and deep learning, digital intervention methods have rapidly emerged. Schools can use artificial intelligence technology to build a platform for adolescent health management, establish a management mechanism that spans the full process from substance use screening warnings to intervention tracking, and enhance the coverage and accuracy of screening warnings. This platform can also incorporate the psychological health status of adolescents, thereby supporting the creation of personalized health records. In addition, precise assessment and prediction of student substance use problems and hierarchical classification intervention tracking through artificial intelligence technology can reduce the incidence of risky behavior. It is worth noting that when introducing digital intervention methods such as intelligent robots and applications, effectiveness and risk assessments should be conducted, operational procedures should be refined, and the potential of digital interventions should be truly realized.

Resources from families, schools, communities should be integrated to form joint efforts. When schools intervene in adolescent substance use problems, they need to consider protective factors from families, and students also need to recognize the importance of social influences. Currently, there are a variety of diverse intervention measures based on individual entities such as families, communities, and schools, and their effectiveness is significant; however, there is a lack of linkage between these entities. In the future, schools can encourage parents and communities to actively participate in the project while ensuring the integrity of their own intervention plans and managing and coordinating resources.

Psychological health interventions should be integrated, and comorbidity risks should be emphasized. Early substance use in adolescents is related to their psychological health status[85]. Identifying potential psychological health problems in adolescents and intervening in a timely manner can help reduce substance use risks[86]. Therefore, the early identification and intervention of both cannot be separated. When schools screen students for psychological health problems, they should pay attention to substance use, and when implementing substance use interventions, they should pay attention to potential psychological health problems in high-risk groups. This not only maximizes the use of school resources but also prevents adolescents from engaging in risky behavior due to comorbidities.

Furthermore, since this study is a scoping review, we did not calculate specific variable values, nor did we conduct a bias risk analysis. This is a limitation of this study.

## CONCLUSION

This article outlines substance use prevention interventions for adolescents in educational environments and their implementation effects. We found that overall intervention measures include curriculum interventions focusing on cognitive-behavioral skill enhancement, exercise interventions, peer interventions and family-school collaboration, and electronic interventions. Except for electronic interventions, which have uneven implementation effects, intervention measures are beneficial in alleviating adolescent substance use problems to varying degrees. In addition, adolescents in different educational stages have different developmental characteristics, and intervention measures should be more targeted and focused. The educational environment has unique advantages for implementing intervention plans, and equipment and human resources can be used to provide adolescents with various types of intervention measures. However, implementation of interventions in the educational environment also faces challenges such as stigmatization, inadequate coordination among multiple resources, and poor implementation effects. In the future, school-based intervention measures can make full use of artificial intelligence technology, jointly intervene with families and communities, and pay attention to the comorbidity risks of substance use disorders and mental health issues.



## FOOTNOTES

**Author contributions:** Liu XQ designed the study; Liu XQ, Guo YX, and Wang X wrote the manuscript and conducted the literature analyses; and all authors contributed equally to this work and approved the final manuscript.

**Conflict-of-interest statement:** All the authors report no relevant conflicts of interest for this article.

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**S-Editor:** Chen YL

**L-Editor:** A

**P-Editor:** Chen YX

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