Systematic review: Internet-based program for youth smoking prevention and cessation

By: Eunhee Park and Emily Drake.

Abstract:

Purpose

To review the characteristics and effects Internet-based youth smoking prevention and cessation programs.

Design

Systematic review of published articles in peer-reviewed journals in the past 10 years, focused on Internet-based youth smoking prevention and cessation programs.

Methods

Twelve articles were selected based on the following criteria: studies reporting the outcomes of Internet-based smoking cessation or prevention intervention programs for adolescents who are younger than 24 years.

Findings

The components of youth Internet-based smoking intervention programs are analyzed based on study features (i.e., sample, design, theoretical basis, analysis, outcome measures) and program characteristics (i.e., focus, setting, frequency, duration, intensity, and different components) that make the programs effective. The most common components of effective Internet-based programs are identified as the following: the use of multimedia, tailored approaches, personalized feedback, and interactive features.

Conclusions

The characteristics and effects of the programs vary, but most programs show positive results in youth smoking prevention and cessation in spite of the studies' limitations.

Clinical Relevance

The evidence from this review provides useful information of recent efforts related to Internet-based youth smoking prevention and cessation programs, which can have significant clinical implications in developing future innovative youth smoking prevention and intervention programs.

Article:

Youth smoking has become a serious concern in recent years (Centers for Disease Control and Prevention [CDC], 2012; U.S. Department of Health and Human Services [DHHS], 2012). For the past few decades, although the overall smoking rate has decreased substantially, it has decreased far more slowly for young people (CDC, 2011). Notably, since 2003 the youth smoking rate has declined only very slowly and the smokeless tobacco use rate remains stalled (CDC, 2012). Every day approximately 3,800 youths and 1,800 adults initiate smoking, with about 1,000 youths becoming daily smokers (CDC, 2012). Overall, 23.9% of high school students and 8.2% of middle school students used tobacco products in 2009 (CDC, 2010). This is a critical issue since young people are more vulnerable to starting use and becoming addicted to tobacco; 88% of current adult smokers, an estimated 45.3 million people, took up the habit during their adolescent years (CDC, 2011, 2012).

Ever since the harmg caused by smoking first came to public attention, healthcare researchers have implemented different interventions targeting youths. Although different types of prevention and intervention strategies have been attempted to deal with this complex youth smoking issue, the effectiveness of youth tobacco interventions is still unclear and presents a challenge (CDC, 2012). In the current environment, where tobacco companies are introducing innovative tobacco products such as attractive flavored smokeless tobacco products, and continue to strategically direct their marketing strategies for these tobacco products at a youthful population, the need for effective, age-appropriate interventions is more urgent than ever.

The Internet can have an impact on smoking and other health behaviors, particularly for youth populations, as adolescents spend a significant proportion of their time using the Internet (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013). According to the Pew Internet survey, 95% of all teens are online and 74% of teens are mobile Internet users (Madden et al., 2013). The developmental characteristics of adolescence by nature, including constructing self-identities, fostering intimate social relationships, seeking stimuli, and avoiding boredom, make the Internet extremely attractive with its interactive features, fast overloads of information, and fun activity sources. Therefore, as researchers have noted the increasing influence of the Internet on adolescents' daily lives, they have initiated efforts to investigate the Internet as a source for health behaviors, including smoking behaviors (Crutzen et al., 2011).

In spite of this increasing attention from researchers and the growing number of Internet-based programs on smoking prevention and cessation for youth, no studies have examined Internet-based smoking prevention programs focusing on youth systematically. Only a limited number of studies have reviewed Internet-based interventions for smokers (Civljak, Sheikh, Stead, & Car, 2013; Hutton et al., 2011). The purpose of this systematic review is to investigate how the Internet is used for youth smoking prevention programs and how effective the Internet can be as a tool for youth smoking intervention programs. Thus, this review aims to provide (a) trends and gaps of current studies in youth Internet-based programs, (b) characteristics and effectiveness of youth Internet-based smoking interventions, and (c) methodological issues of identified studies. Therefore, this review is expected to inform the future direction of youth smoking prevention and cessation studies.

Methods

This review followed the protocol of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for systematic reviews (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009). Based on the purpose of the study, inclusion and exclusion criteria are in place and the literature search process is described in **Figure 1.**

Figure 1. Flow chart of the literature search process

Figure 1. Flow chart of the literature search process
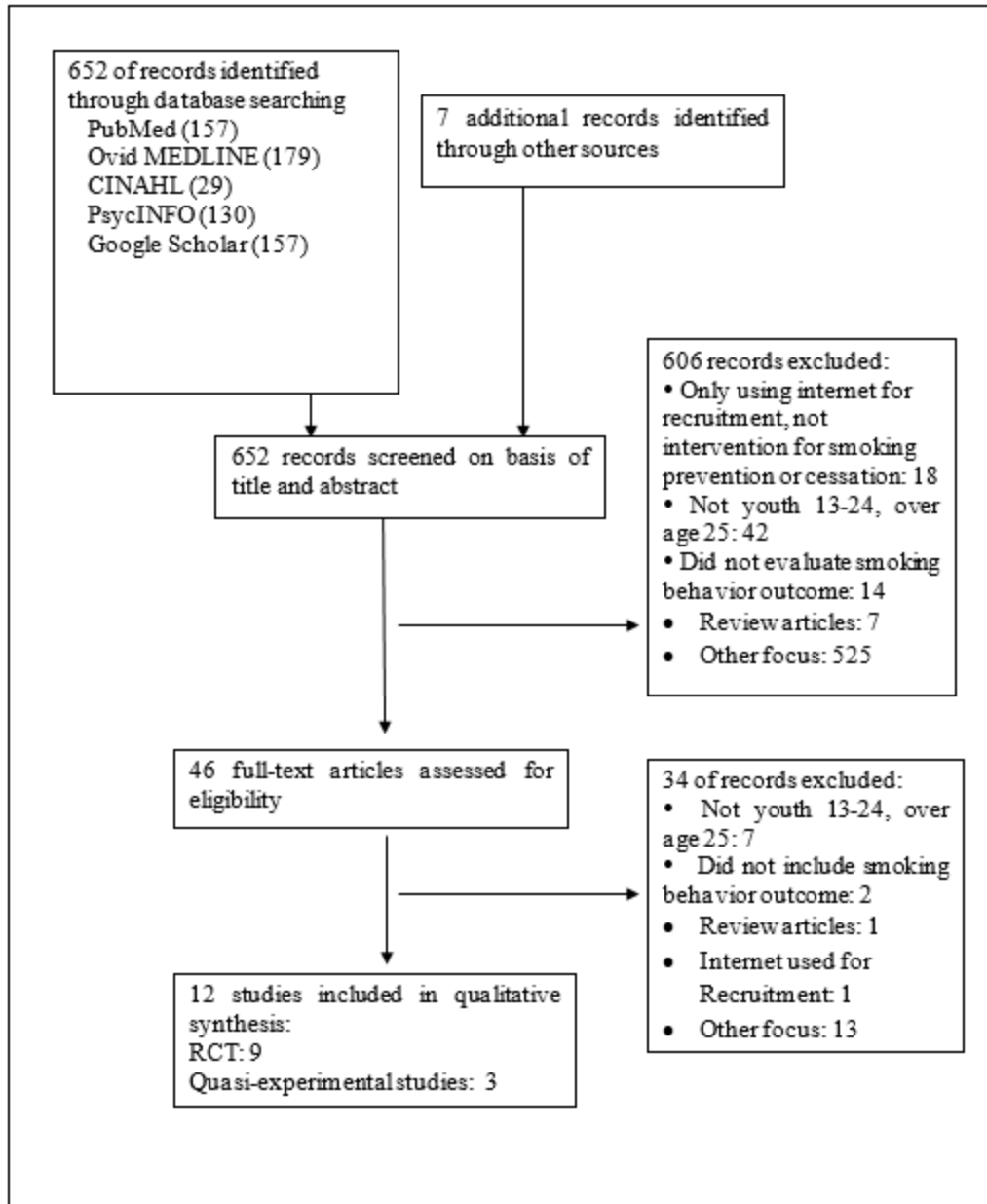
Inclusion Criteria

Studies were included if they were published in a peer-reviewed journal in the past 10 years; they were published in English; the population studied was younger than 24 years; and they included Internet-based interventions as a smoking cessation or prevention tool. Studies were excluded if participants were over 24 years old; the Internet was used simply as a modality for the research survey tool or as a recruitment tool; they did not include smoking behavior information; or they did not provide data-based results including protocol- and feasibility-focused papers without the

findings of effects in smoking status. The search was limited to peer-reviewed articles written in English and published in the past 10 years.

Search Strategy

A comprehensive search was conducted using five search engines: , Ovid MEDLINE, the Cumulative Index of Nursing and Allied Health Literature (CINAHL), PsycINFO, and Google Scholar (Conn et al., 2003). In addition to these search engines, a manual search was conducted. The following search terms were combined in each category: smoking (smoking, tobacco, health behavior, health promotion); adolescents (children/child, youth/youths, adolescents, teenager/teenagers, young people, young adult/ young adults); and Internet (health-related Internet use, Internet use, Internet, web-based, e-health).

Data Extraction and Synthesis

All study titles and abstracts were initially evaluated by one reviewer based on the eligibility criteria. After the initial screening, full articles were reviewed for eligibility by two authors and the agreed-upon articles were included. After confirming eligibility, one reviewer entered components of the articles in the evidence tables and the second reviewer confirmed the accuracy of the coding. The coding scheme was developed based on the purpose of the studies and the guidelines of the systematic reviews (Moher et al., 2009; West et al., 2002). In the case of any disagreement among reviewers, external review was considered.

Results

Study Selection

The initial search identified 652 articles (**Figure 1**). The titles and abstracts of these articles were reviewed to determine whether they met the inclusion criteria, which resulted in a list of 46 articles that were potentially relevant. These 46 articles were then fully reviewed to confirm they met the inclusion criteria listed below, and reviewed to identify the purpose, sample, theoretical framework, method, and findings of each. When subjected to closer scrutiny, 33 articles were excluded since their focuses did not match the study criteria. Ultimately, 12 articles were included (**Tables 1–5**).

Features of Studies

Aims

The purposes of the 12 studies utilizing Internet-based programs for youth smoking prevention or cessation programs are described in **Table 1**. The majority of these programs (64%) focused on smoking reduction or cessation and only one focused on smoking prevention (Shegog et al., 2005). Three programs aim for both purposes (Bowen, Henderson, Harvill, & Buchwald, 2012; Buller et al., 2008; Norman, Maley, Li, & Skinner, 2008).

Table 1. Summary of internet-based programs based on aims, settings, and population

Aims	Setting	First author, year	Age, country	N	Status
Cessation (n=8)	School	Evers, 2012	10-14 years old, US	1590	Current and past smokers or drug users
		Woodruff, 2007	14-19 years old, US	136	Smokers
		Mermelstein, 2006	14-19 years old, US	351	Smokers
		Chen, 2006	Senior high school students, Taiwan	77	Smokers
	Home	Patten, 2006	11-18 years old, US	139	Smokers
	Mall (email f/u)	Abroms, 2004	15-17 years old, US	70	Smokers and nonsmokers (girls)
	College	Abroms, 2008	18-23 years old, US	83	Smokers interested in quitting in next 6 months
		An, 2008	18-24 years old, US	517	Smokers
Combination of Prevention & cessation (n=3)	School	Buller, 2008	10-15 years old, US; 10-16 years old, Australia	1,234 +2,077	Smokers and nonsmokers
		Norman, 2008	9th-11th grade, Canada	1,402	Smokers and nonsmokers
	Summer camp	Bowen, 2012	12-18 years old, US	113	Smokers and nonsmokers (American Indians)
Prevention (n=1)	School	Shegog, 2005	average 12 years old (6th grade), US	2,227	Smokers and nonsmokers

Settings

The settings of the programs varied (**Table 1**). Most programs were delivered using only the Internet (Abroms et al., 2004; An et al., 2008; Norman et al., 2008; Patten et al., 2006). However, several Internet-based programs were delivered from school-based settings (Buller et al.,2008; Chen & Yeh, 2006; Evers et al., 2012; Mermelstein & Turner, 2006; Norman et al., 2008; Shegog et al., 2005; Woodruff, Conway, Edwards, Elliott, & Crittenden, 2007) and community-based settings, such as summer camp (Bowen et al., 2012). Group-based setting (Abroms, Windsor, & Simons-Morton, 2008) were also used to deliver basic components.

Population

Most studies were conducted in the United States, with only three studies conducted outside of the United States (**Table 1**). In total, 10,016 participants are included in the 12 studies. Ages varied from 11 to 23 years, but the majority of studies focused on either middle school students (Buller et al., 2008; Evers et al., 2012; Shegog et al., 2005), high school students (Abroms et al., 2004; Chen & Yeh, 2006; Mermelstein & Turner, 2006; Norman et al., 2008), or both (Bowen et al., 2012; Patten et al., 2006; Woodruff et al., 2007). Only two studies were conducted for young adults (Abroms et al., 2008; An et al., 2008). As most programs focused on smoking cessation, four studies (33.3%) included nonsmokers (Bowen et al., 2012; Buller et al., 2008; Norman et al., 2008; Shegog et al., 2005); the remaining studies (66.7%) included only smokers. One study includes girls only (Abroms et al., 2004), and one study focused on the American Indian population (Bowen et al., 2012).

Study design

Most studies (75%) used a two-armed randomized controlled trial (RCT), while quasi-experimental study designs were used in three studies (**Table 2**). Quasi-experimental studies included a two-group comparison without randomization (Abroms et al., 2004; Chen & Yeh, 2006) and single group with a pre and post comparison (Shegog et al., 2005). Among two-group comparison studies, although all studies used the Internet as the mode of delivering the

program in the intervention group, there were differences in the control groups (**Table 3**). In four studies, control groups provided no treatment (Bowen et al., 2012; Chen & Yeh, 2006; Evers et al., 2012; Woodruff et al., 2007), and in two studies, control groups provided traditional health education programs, which do not include smoking specific programs (Buller et al., 2008; Norman et al., 2008). Only in four studies did control groups provide non-Internet-based smoking cessation or prevention programs (Abroms et al.,2004, 2008; Mermelstein & Turner, 2006; Patten et al., 2006), and in one study, the control group provided brief information about other smoking cessation websites (An et al., 2008).

Table 2. Summary of study design and methods

First author, year	Study design	Unit of randomization	Outcome measure	Analysis	Follow up	Sites
Bowen, 2012	RCT	Individual	Smoking Prevention Interactive Experience ASPIRE	T-test, Chi-square test, Factor analysis	At post intervention	1 summer camp
Evers, 2012	RCT	School	Youth Risk Behavior Surveillance Survey (YRBSS)	Random effects logistic models, Last observation carried forward (LOCF), Repeated measures models	3 months & 14 months	22 middle schools
Abrom, 2008	RCT	Individual	Salivary cotinine analysis (6 month), Fagerstrom Test for Nicotine Dependence (FTND)	T-tests, Chi-square	3 months & 6 months	1 college
Norman, 2008	RCT	Individual	Likelihood of Action Scale for Smoking–Adolescents (LASS-A)	Multi-level logistic regression	3 months & 6 months	14 secondary schools
Buller , 2008	RCT	School	Piece et al.'s susceptibility measure et al.	Linear mixed models	At post intervention	25(Australia) +21middle schools (US)
An, 2008	RCT	Individual	Hooked on Nicotine Checklist (HONC), CO breath testing	Logistic regression modeling	8, 20, and 30 weeks	1 college
Woodruff, 2007	RCT	School	National Youth Tobacco Survey/American Legacy Foundation, the California Youth Tobacco Survey	Generalized estimating equation	3 months & 12 months	14 high schools
Mermelstein , 2006	RCT	School	Carbon monoxide level	Chi-square, Hierarchical linear modeling, Mixed model logistic regression	At post intervention & 3 months	29 high schools
Patten, 2006	RCT	Individual	Fagerstrom Tolerance Questionnaire, Cigarette Timeline, CO level.	Chi-square test, Generalized estimating equations (GEE)	4, 8, 12, 24 & 36 weeks	3 States
Chen, 2006	Quasi-experimental study	N/A	Modified smoking risk questionnaire	Chi-square test, T-test, ANCOVA, correlation	At post intervention	1 high school
Shegog, 2005	Quasi-experimental study (Single group)	N/A	Texas Tobacco Initiative Survey	Paired t-test, General linear model	At post intervention	9 middle schools
Abroms, 2004	Quasi-experimental study	N/A	Youth Risk Behavior Surveillance Survey (YRBSS)	Chi-square test, T-tests	At post intervention	1 local mall in one city

Note. RCT=randomized controlled trial

Outcome measures and follow-up

Although outcome measures vary by the purpose of the studies, most studies assessed smoking behavior (point 30-day abstinence, point 7-day abstinence) as a primary outcome, and four studies confirmed self-report with biochemical measures in smoking cessation studies. Smoking uptake, intention, attitudes, self-efficacy, and knowledge are common constructs used to evaluate

the effect of smoking prevention. Follow-up assessments were conducted anywhere from immediately postintervention to 6 months later with various outcome measures, depending on the purpose of the studies (**Tables 2 and 3**). Most (58.3%) of the studies evaluated the program at multiple points (**Table 2**), and the follow-up period of the interventions ranged from 1 month to 14 months from the pretest (Evers et al., 2012). However, 41.7% of studies evaluated the effectiveness or efficacy of the program only once at postintervention without further follow-up (Abroms et al., 2004; Bowen et al., 2012; Buller et al., 2008; Chen & Yeh, 2006; Shegog et al., 2005).

Table 3. Characteristics of youth internet-based programs

First author, year	Theoretical Basis	Treatment			Control	Frequency Duration Intensity
		Program	Personal involvement	Description		
Bowen, 2012	Not indicated	Adapted SmokingZine	Initial set up+ giving time for the program	Culturally tailored educational modules with multimedia components	No treatment	1 hour/session Daily access Over 4 weeks
Evers, 2012	Transtheoretical Model	Your Decision Count™	Initial set up+ giving time for the program	Web-based with tailored feedback+ family guide material	No treatment	30-minute/session Three sessions Over 3 months
Abroms, 2008	Social cognitive theory	X-Pack	Personal counseling+ counseling emails	Personal counseling+ self-help kit+ counseling email-based f/u	Clearing the Air program (adult-oriented in-person counseling) w/o f/u	15minutes(counseling) + Counseling E-mails: 10-12 weekly Over 6 months
Norman, 2008	Likelihood of Action Index and multiple health behavior models	Adapted Smoking Zine	Group motivational interview+ sending f/u emails	Web site+ paper journal+ small group motivational interview+ tailored f/u emails	Review of website on climate change+ journal+ small group discussion	60-min/ session One session+ Monthly e-mails Over 6 months
Buller, 2008	Social cognitive theory/ Arousal theory	Consider This	Initial set up+ giving time for the program	Educational modules with multimedia +tailored feedback	Standard health education	45-60 minutes Once
An, 2008	Social cognitive and problem behavior theory	RealU	Sending f/u emails	Online magazine with tailored feedback + peer support email	Informed of smoking contest and other smoking cessation websites	20 weekly website visits Over 30 weeks
Woodruff, 2007	Social learning and stage of change, social suppose/group interaction theories	Breathing Room Virtual world	Counseling in virtual world+ Motivational interview	Virtual reality program with avatar, interaction with peers and counselor + motivational interview	No treatment	45 minutes/session 7 weekly sessions Over 7 weeks
Mermelstein, 2006	Not indicated	Not on Tobacco+ NOT plus	Phone calls	4 phone call + website [Not Hooked] + quit line	Standard NOT program (Control group: 10 weekly sessions)	5 weekly session+ Follow up sessions Over 6 months
Patten, 2006	Social learning theory, health communication and decision making theories	Stomp Out Smokes (SOS)	Response to questions	Information, journaling, art gallery, Q&A, quiz	Clinic-based, brief office intervention (Counseling + motivational interview)	Over 6 months (Control group: 40-60min/session 4 weekly sessions Over 4 weeks)
Chen, 2006	Social learning theory	Plus an Internet assisted	Regular group sessions+ set up	Information, group discussion, role-play + discussion forum	No treatment	2 hours/session Weekly sessions Over 6 weeks
Shegog, 2005	Not indicated	Headbutt	Initial set up	Tailored feedback + a graphic character, multimedia components	N/A	20-50 minutes/session Once
Abroms, 2004	Not indicated	STRENGTH + Ezine	Initial health program	STRENGH program+ Health Ezine (email magazine with quiz and an advice column)	STRENGH program only without email sessions	10 Ezine volumes+ 20 weekly e-mails Over 7 months

Note. f/u=follow up; w/o=without

Characteristics of Youth Internet-Based Programs

Theoretical models

Most programs used theoretical frameworks when developing or using interventions (**Table 3**). Several health behavior theories have been applied for developing the content of the programs, of which Social Cognitive Theory was most frequently used (Abroms et al., 2008; An et al.,2008; Buller et al., 2008; Chen & Yeh, 2006; Patten et al., 2006; Woodruff et al., 2007). The Likelihood of Action Index Theory was also used (Bowen et al., 2012; Norman et al., 2008), as well as the Health Belief Model, Theory of Planned Behavior, and Prochaska's Transtheoretical Model stages of change (Evers et al., 2012). Quite a few studies incorporated motivational interviewing techniques (Buller et al., 2008; Norman et al., 2008; Patten et al., 2006; Woodruff et al., 2007). However, some studies did not specifically indicate which theory or framework was used (**Table 3**).

Intensity, frequencies, and duration

Although all the studies used Internet-based, youth smoking prevention or cessation programs, the intensity, frequencies, and duration of the delivery of the programs varied considerably (**Table 3**). The frequency of the programs was generally on a weekly to monthly basis, while the duration of the programs ranged from only once (Buller et al., 2008; Shegog et al., 2005) to 7 months. Most program sessions lasted from 30 min to 2 hr when the Internet was used as a mode of delivering the programs.

Unique characteristics of Internet-related components

Internet-based interventions consisted of different components, such as mode of delivery and follow-up source (**Tables 3 and 4**). Most programs used it mainly as a source of information delivery using the web site (Bowen et al., 2012; Buller et al., 2008; Chen & Yeh, 2006; Evers et al., 2012; Norman et al., 2008; Patten et al., 2006; Shegog, 2005) or e-magazines (Abroms et al., 2004; An et al., 2008) and/or as a follow-up source, using emails (Abroms et al., 2008; An et al., 2008; Norman et al., 2008) or booster sessions (Mermelstein & Turner, 2006). Most programs provided multimedia-based components, such as video content and stories (Bowen et al., 2012; Buller et al., 2008; Evers et al.,2012; Patten et al., 2006; Shegog et al., 2005), which can attract adolescents effectively. In addition, Internet-based components were used to enhance interaction and engagement by providing tailored feedback to the participants and interactive activities in most programs based on the participants' smoking status (**Table 3**). Tailored contents of the target population were also provided to the target population (Bowen et al., 2010) and personalized feedback by assessing the current or former smokers' smoking status and changing status (Abroms et al., 2008; Buller et al., 2008; Evers et al., 2012; Norman et al., 2008; Shegog et al., 2005) were unique components that the Internet could provide. In addition, Internet-based components—interactive activities such as discussion boards (Bowen et al., 2012; Chen & Yeh, 2006), questions and answers (An et al., 2008; Patten et al., 2006), and self-journaling (Patten et al., 2006)—were also commonly used components to facilitate teenagers' engagement, allowing them to provide effective feedback. One study utilized

a virtual reality program using avatars, which allows adolescents to explore the decision-making process through online role playing and discussion regarding smoking (Woodruff et al., 2007).

Incorporation of non-Internet components

Although the programs used Internet components in the program delivery, the programs had educational non-technology-based components with personal involvement (**Table 4**). The personal involvement varied by the study. A few programs required minimal assistance only for setting up the program in the beginning (Bowen et al., 2012; Buller et al., 2008; Evers et al., 2012; Shegog et al., 2005). Several programs included some personal components delivered online, such as tailored counseling emails by a counselor or an online discussion led by a program moderator or peer supporters (Abroms et al., 2008; An et al., 2008; Patten et al., 2006). Some programs included personal contacts combined with use of the Internet, such as general group sessions (Abroms et al., 2004; Mermelstein & Turner, 2006), counseling (Abroms et al., 2008), in-person group discussion or motivational interviews (Norman et al., 2008; Mermelstein & Turner, 2006; Woodruff et al., 2007), role playing (Chen & Yeh, 2006; Mermelstein & Turner, 2006), additional materials (Abroms et al., 2008), and phone calls (Mermelstein & Turner, 2006).

Table 4. Effect of youth internet-based programs based on the program characteristics

Categories based on the use of internet	Author, year	Treatment group (components)*	Control group	Outcomes	Efficacy
Individual based internet program	Patten, 2006	**Information, journaling, art gallery, Q&A, quiz**	Clinic based program (completely offline counseling)	**Quite rates (30 day abstinence with bio measure)**: Quit rates were higher for control group than intervention group (12% vs. 6%) at week 24 (p>0.05) and (13% vs. 6%) at week 36 (p>0.05).	-/-
				Number of days: Treatment group was associated with a significantly greater reduction in average number of days smoked than control group (P = 0.006).	±/±
	An. 2008	**Online magazine with tailored feedback + peer support email**	Other online information about smoking	**Quit rates (7day and 30 day abstinence with bio measure)**: Quit rates at week 30 was significantly higher in the treatment (Self-report: 40.5%, CO: 33.1%) vs. the control group (Self report: 23.1%, CO: 16.9%), (p<0.05).	+/±
				Number of smoking days: No difference between groups. **Readiness to quit:** Increased in the intervention group compared to the control group (p<0.05).	+
Individual based internet program provided in a group setting	Bowen, 2012	**Culturally tailored educational modules with multimedia components**	No treatment	**Smoking status:** Not significant changes in both groups (Proportion of nonsmokers in the treatment group and control 85% vs. 83%, 83% vs. 80% at baseline vs. f/u)	-
				Smoking intention: Decline in the intentions to smoke a cigarette in the treatment group and increase in the control group (p<0.5). **Attitudes**: Changes in attitudes about drug effects and negative effects of smoking only in the treatment group in a positive, intended direction (p<0.5). No changes in the attitudes regarding social action in both groups.	+
	Evers 2012	**Web-based with tailored feedback+** family guide material	No treatment	**Quit rates (30 day abstinence):** Among current users at baseline, higher percentage of quitters in the treatment group vs. control group (33.0% vs. 17.1%, p<0.05) at 3 month and at 14 month (28.7% vs. 22.4%, p>0.05). **Smoking stage:** Increase (3.4%) in the treatment group in action/maintenance vs. decrease (-3.7%) in the control group at posttest	+/±

				and 3 month, after controlling for covariates, over time (p<0.5). No difference at 14 month. Among people at pre-action stage, there were higher percentage of quitters in the treatment group vs. control group (39.6% vs. 24.6%, p<0.001) at 3 month and at 14 month (36.9% vs. 32.1%, p>0.05).	
	Buller 2008	**Educational modules with multimedia +tailored feedback**	Standard health education	**Quit rates (30 day abstinence):** Quit rates were higher in the intervention group vs. control in Australia (4.9% vs. 3.0%, p<0.05). Among smokers, 30-day smoking prevalence (whole cigarette) was reduced in the treatment group after controlling for grade level, compared to the control group in the Australia (whole cigarette p<0.05, puff >0.05) and in the US (p>0.05). **Smoking uptake:** Non-smokers are less likely to smoke in the treatment, compared to the control group in the US and Australia (p>0.05)	+
	Shegog, 2005	**Tailored feedback + a graphic character, multimedia components**	N/A	**Smoking intention:** Decreased at the post intervention (p<0.05). **Attitude about use of the cigarettes:** Changed in a positive direction (p<0.05).	±
Combination with off-line group-based educational components	Norman, 2008	Web site+ paper journal+ small group motivational interview+ **tailored f/u emails**	Different program with combination (not about smoking)	**Cigarette use:** Nonsmokers decreased likelihood of heavy cigarette use and no significant changes in smokers **Intention:** Nonsmokers (p>0.5) and smokers (p<0.5) reduced the likelihood of heavy cigarette use adoption in the treatment group for 6 months. **Resistance:** Nonsmokers (p>0.5) and smokers (p>0.5) increased their likelihood of high resistance to continued cigarette use in the treatment vs. control group for 6 months.	±/±
	Woodruff, 2007	**Virtual reality program with avatar, interaction with peers and counselor +** motivational interview	No treatment	**Quit rates (7 day abstinence):** Significantly higher in the intervention group than control (p<0.05) at post assessment, but no difference at 12 month f/u **Smoking use:** Smoked fewer cigarettes and few days in the treatment group than the control group at post intervention (p<0.05), but no difference in the at 3 month and 12 month f/u. **Latency to first cigarette and readiness/intentions to quit:** Improved in both group, but no difference between groups	+/-
	Chen, 2006	**Information,** group discussion, role-play + **discussion forum**	No treatment	**Daily cigarette consumption:** Cigarette consumption was reduced (p<0.05) and lower in the intervention vs. control group (p<0.05). Quit attempt was increased in the experimental group (p<0.05) and higher compared to the control group (p<0.05). **Attitude towards smoking and self-efficacy:** Self-efficacy was increased and higher in the intervention vs. control (p<0.05). Attitudes (likelihood of smoking) was decreased and lower in the intervention group vs. control (p<0.05).	+
Internet-based component as follow up sources or booster sessions	Abroms, 2008	Personal counseling+ self-help kit+ counseling **email-based f/u**	Different program w/o internet components	**Quit rates (7 day abstinence with bio measure):** Higher quit rates (31.3 and vs. 2%) in the treatment vs. the control at 3month (*p>0.5*) and (20.0 vs. 5.7%) 6 month (*p>0.5*). **Quit days and number of cigarettes:** More consecutive days at the 3 (p<0.5) and 6month (*p<0.5*) in the treatment vs. control group. Changes in the number of cigarettes is higher in the treatment vs. control at 3 month (*p<0.5*) and at 6 month (p>0.05).	+/±
	Mermelstein, 2006	4 phone call + **website** + quit line	Same group-based program (phone calls only) w/o internet components and phone calls	**Quit rates (7 day abstinence with bio measure):** Quit rates are higher in the intervention vs. control (12.2% vs. 4.7%) at the end of the program (p = .06) and (20.4% vs. 15.7%) at 3-month follow-up (p < .05) in the treatment vs. control group, controlling for the covariates.	±/+
	Abroms, 2004	STRENGH program+ **Health Ezine (email magazine with quiz and an advice column)**	No follow up	**Smoking rates (30 day prevalence):** Differences in rates of smokers between the treatment vs. control group (16.2 vs. 18.2%) was not significant (p>0.05).	±

Note. * Components written in bold indicates the internet-based components; + Positive outcomes; ± = Statistically non-significant, but clinically important; - = no beneficial effects demonstrated; +/± Positive outcomes in a short term and non-significant in a long-term follow up; ±/+ Statistically non-significant but positive outcomes in a short term and statistically significant in a long-term follow up

Effects of Youth Internet-Based Interventions

Cessation

Most studies showed positive outcomes in the efficacy of Internet-based components, with higher rates of quitting smoking in the intervention group compared to the control group with statistical significance (**Table 4**; Buller et al., 2008; Evers et al., 2012; Mermelstein & Turner, 2006; Woodruff et al., 2007), including immediately postintervention and at 3 months (Evers et al., 2012; Mermelstein & Turner, 2006). Interestingly, one study reported the opposite results (Patten et al., 2006). In this study, the treatment group without personal components tended to report lower quit rates compared to the control group, which included an in-person component although it was not a statistically significant result (Patten et al., 2006). Among the 12 relevant studies, most showed positive results regarding the efficacy of the program being evaluated (**Table 4**). Quit rates ranged from 4.9% (Buller et al., 2008), 12.2% (Mermelstein & Turner, 2006), and 16.2% (Abroms et al., 2004) at postintervention; 1% (Patten et al., 2006) and 42.8% (An et al., 2008) at 2 months; 3% (Patten et al., 2006), 20.4% (Mermelstein & Turner,2006), 31.3% (Abroms et al., 2008), and 33.0% (Evers et al., 2012) at 3 months; 6% (Patten et al., 2006) and 20.0% (Abroms et al., 2008) at 6 months; 40.5% at 30 weeks (An et al., 2008); 6% at 9 months (Patten et al., 2006); and 28.7% at 14 months (Evers et al., 2012). However, in most studies, significant positive results were not reported with long-term follow-up (Abroms et al., 2008; Evers et al., 2012; Woodruff et al., 2007). Higher quit rates in treatment groups than control groups did not show statistical significance at 3 months (Abroms et al.,2008), 6 months (Abroms et al., 2008), 12 months (Woodruff et al., 2007), and 14 months (Evers et al., 2012). This result is consistent with other outcomes, such as a positive increase in action or maintenance stage at 3 months but no significant difference at 14 months reported (Evers et al., 2012). Rarely were there studies that showed long-term positive results to 30 weeks (An et al., 2008), although other outcome measures such as the number of days smoked at 6 months showed positive results in long-term follow-up in one study (Abroms et al., 2008).

Prevention

For smoking prevention programs, youth in the treatment group showed positive results in decreasing their intention to smoke with statistical significance in most studies (Bowen et al., 2012; Buller et al., 2008; Shegog et al., 2005). In addition, resistance was increased in the treatment group compared to the control group in spite of the statistically insignificant difference in intention to smoke (Norman et al., 2008). Smoking uptake did not show statistical difference, although a higher proportion of nonsmokers in the treatment group compared to the control group (Bowen et al., 2012) and nonsmokers were less likely to smoke in the treatment group compared to the control group (Buller et al., 2008). Positive directional changes regarding attitudes toward smoking and self-efficacy were also reported with statistical difference in some studies (Chen & Yeh, 2006; Shegog et al., 2005), but appeared inconsistent in another study (Buller et al., 2008).

Subpopulation

Results based on subpopulation were also reported in a few studies. There were inconsistent results regarding the effectiveness of these programs changes depending on the age of the target population. In only a few reports that looked at subpopulations by age when examining the effectiveness of a program was the program found to be more effective for those in Grade 8 or above than those in Grades 6 or 7 in middle school (Evers et al., 2012). Another study also showed that older students were more likely to change their smoking behaviors than younger students in the middle school population (Shegog et al., 2005). The results were more inconsistent for high school students, where students in Grade 10 were reported to be the most responsive among students in Grades 9 to 11 (Norman et al., 2008), while another study found that the younger population were more likely to quit among students in Grades 9 to 12 (Mermelstein & Turner, 2006).

Methodological Issues

Internal validity

Based on the guides of West et al. (2002), quality of studies and strength of evidence of the selected studies are reviewed (**Table 5**). Although all studies did not have an issue regarding study question, population, comparability of subjects, interventions, results, and discussions, some methodological issues can introduce a risk of potential bias regarding randomization, outcomes, and statistical analysis (**Table 5**). Although most studies utilized RCT study design, there are still some critical issues that can introduce threats to internal validity. Due to the nature of the study characteristics conducted in community or school settings, blinding was not applied in most studies; only one study used blinding for participants (Bowen et al., 2012). In addition, studies that used individual randomization may have caused a diffusion effect when the intervention was conducted in a group setting (Bowen et al., 2012; Norman et al., 2008). The studies that used clustered randomization reduced the contamination of the intervention effect, but there are issues regarding lack of description of the concealment process in randomization. Although the majority of studies did not have an issue regarding the analysis, a few did not use intent to treat analysis or failed to report if there were issues related to loss of follow-up (Abroms et al., 2004; Bowen et al., 2012; Chen et al., 2006; Norman et al., 2008). Studies that did not use randomized control have some potential biases to internal validity (Abroms et al., 2004; Chen et al., 2006; Shegog et al., 2005), including limited comparability of subjects (Abroms et al., 2004). There are some remaining concerns regarding the outcome measure, as most studies used self-report to evaluate the study outcomes. Only four studies utilized a way of objective measure by using the biochemical method (Abroms et al., 2008; An et al., 2008; Mermelstein, 2006; Patten et al., 2006). In addition, some studies required a more detailed report of psychometric properties of the instruments (An et al., 2008; Bowen et al., 2012; Shegog et al., 2005; Woodruff et al., 2007), although self-reported instruments are existing instruments previously used in the field of youth smoking studies.

Table 5. Evaluation of study quality

First Author, year	Study question[a]	Study population[b]	Comparability of subjects[c]	Randomization[d]	Blinding[e]	Interventions[f]	Outcomes[g]	Statistical analysis[h]	Results[i]	Discussion[j]
Bowen, 2012	●	●	●	◐	◐	●	◐	◐	●	●
Evers, 2012	●	●	●	◐	○	●	●	●	●	●
Abrom, 2008	●	●	●	●	○	●	●	●	●	●
Norman, 2008	●	●	●	◐	○	●	●	◐	●	●
Buller , 2008	●	●	●	◐	○	●	●	●	●	●
An, 2008	●	●	●	●	○	●	◐	●	●	●
Woodruff, 2007	●	●	●	◐	○	●	◐	●	●	●
Mermelstein, 2006	●	●	●	●	○	●	●	●	●	●
Patten, 2006	●	●	●	◐	○	●	●	●	●	●
Chen, 2006	●	●	●	N/A	N/A	●	●	○	●	●
Shegog, 2005	●	●	N/A	N/A	N/A	◐	◐	●	●	●
Abroms, 2004	●	●	◐	N/A	N/A	●	●	◐	●	●

Note. ●=Elements are completely addressed; ◐ = Elements are partially addressed; ○= Elements are not addressed.

Note: Elements for evaluation in each domain are as follows: [a]Study question: Is the study question clearly focused and appropriate? [b]Study population: Is the study population well described? Are inclusion and exclusion criteria clear? [c]Comparability of subjects: Is group comparability assured? [d]Randomization: Is adequate concealment method used for randomization? [e]Blinding: Is double-blinding used to treatment allocation? [f] Interventions: Is intervention clearly detailed for all study groups? [g]Outcomes: Is there primary and secondary outcome measures specified? Is the method of measurement used standard, valid, and reliable? [h]Statistical analysis: Is there an appropriate analytic technique used to address study withdrawals, loss to follow-up, missing data, and intention to treat? [i]Results: Are the outcome effect and measures of precision provided? [j]Discussions: Are conclusions supported by results with the consideration of potential biases of the studies?

External validity

Only a few studies attempted to assure external validity for generalization with the effort of having diverse sample representation. A few studies used multiple sites, from multiple schools (Evers et al., 2012; Mermelstein & Turner, 2006; Norman et al., 2008; Shegog et al., 2005; Woodruff et al., 2007) and multiple states (Patten et al., 2006; **Table 2**). Only a few studies described attempts at having diverse groups (Evers et al.,2012; Mermelstein & Turner, 2006; Norman et al., 2008; Woodruff et al., 2007). Thus, it is not sufficient to conclude generalizability of evidence in given studies.

Discussion

This review of Internet-based programs for adolescent smoking prevention and cessation is timely and provides understanding of the benefits of the Internet as a promising tool. A number of Internet-based interventions were developed based on various health behavior theories as their theoretical frameworks and were tested for a diverse population with different intervention frequency, duration, intensity, and study design. Due to these variations, individual study results are difficult to compare and too dissimilar or heterogeneous to combine.

However, in spite of the varying levels of effectiveness (quit rates ranging from 1% to 40%) and even opposite directional results in one study, Internet-based programs represent an emerging field and appear to be feasible to implement. Considering the control group condition and study design, we cannot conclude that Internet-based programs are more effective than person-based programs in the current literature. However, there is enough evidence that Internet-based programs are useful for clinically promising results in youth smoking cessation and prevention from the reported studies with quit rates as high as 40.5% at 30 weeks and positive trends in

smoking prevention. In particular, Internet-based programs show strong evidence in effectiveness when they are used as follow-up sources, and they showed some promise of positive results when combined with various personalized educational strategies with yet limited evidence. These programs have strengths which include the ability to provide a personalized approach, interactive components, and engaging features, such as multimedia components. In addition, considering the low demands of the program delivery, once the program is developed, Internet-based programs show promise based on the ability to deliver the intervention in various settings, such as community, home, and school-based settings.

In addition, there are limitations related to the effectiveness and efficacy of Internet-based programs from these published studies related to methodological issues. Although the RCT method was the most frequent study design used, which is the gold standard for evaluating efficacy or effectiveness, it is still difficult to conclude the effect of Internet-based programs, considering the variability of conditions of control groups and lack of long-term follow up in some studies. In only a limited number of studies, Internet-based programs were compared with control groups with non-Internet-based smoking prevention programs. In addition, considering the variations in program features, it is difficult to conclude which components contributed to the effect of the outcome. In many cases, the Internet was used as an additional component along with personal contacts, and, in most studies, various components were used as a whole.

Conclusions

Although Internet-based programs show great potential for youth smoking prevention and cessation, clearly more research is needed, including diverse populations. In the current studies, youth 11 to 23 years of age demonstrated great variation between gender, developmental level, and culture. Considering the strength of the Internet-based interventions, such as the possibility of culturally tailored intervention for minority groups or subpopulations, interventions could be more targeted for certain subpopulations in future studies. A limited number of studies were conducted that focused on a specific subgroup, such as the American Indian population (Bowen et al., 2012) and girls (Abroms et al., 2004). In addition, most studies did not report outcomes depending on ethnicity, and only one study showed Hispanic and White students as having a more positive change in intentions to not smoke than their African American counterparts (Shegog et al., 2005). Thus, more effective programs should be developed to target specific populations with a more tailored approach. In addition, further studies for smoking prevention could report the effectiveness of specific components used in the selected studies. Considering the results demonstrating the importance of personal contacts in these programs, how to incorporate an in-person approach along with innovative components using available technology on the Internet should also be thoroughly considered for future studies.

Clinical Resources
- American Cancer Society: http://www.cancer.org/acs/groups/cid/documents/webcontent/002963-pdf.pdf
- American Legacy Foundation Legacy for Health:http://www.legacyforhealth.org/content/download/2554/33803/version/4/file/LEG-YA+Toolkit+Web-Single+Pages-3.27.13.pdf
- Campaign for Tobacco-Free Kids: http://www.tobaccofreekids.org/

- Centers for Disease Control and Prevention. Multimedia and Tools. Shareable Media:http://www.cdc.gov/tobacco/multimedia/shareable/index.htm

References

Abroms, L. C., Fagan, P., Eisenberg, M. E., Lee, H. S. H., Remba, N., & Sorensen, G. (2004). The STRENGTH Ezine: An application of e-mail for health promotion in adolescent girls. *American Journal of Health Promotion*, **19**(1), 28–32. doi:http://dx.doi.org/10.4278/0890-1171-19.1.28

Abroms, L. C., Windsor, R., & Simons-Morton, B. (2008). Getting young adults to quit smoking: A formative evaluation of the X-Pack Program. *Nicotine & Tobacco Research*, **10**(1), 27–33. doi:10.1080/14622200701767852

An, L. C., Klatt, C., Perry, C. L., Lein, E. B., Hennrikus, D. J., Pallonen, U. E., … Ehlinger, E. P. (2008). The RealU online cessation intervention for college smokers: A randomized controlled trial. *Preventive Medicine*, **47**(2), 194–199. doi:10.1016/j.ypmed.2008.04.011

Bowen, D. J., Henderson, P. N., Harvill, J., & Buchwald, D. (2012). Short-term effects of a smoking prevention website in American Indian youth. *Journal of Medical Internet Research*, **14**(3), e81. doi:10.2196/jmir.1682

Buller, D. B., Borland, R., Woodall, W. G., Hall, J. R., Hines, J. M., Burris-Woodall, P., … Saba, L. (2008). Randomized trials on consider this, a tailored, Internet-delivered smoking prevention program for adolescents. *Health Education & Behavior*, **35**(2), 260–281. doi:10.1177/1090198106288982

Centers for Disease Control and Prevention. (2010). Tobacco use among middle and high school students—United States, 2000–2009.*Morbidity and Mortality Weekly Report*, **59**(33), 1063–1068.

Centers for Disease Control and Prevention. (2011). *Tobacco use: Targeting the nation's leading killer, 2010*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

Centers for Disease Control and Prevention. (2012). *Preventing tobacco use among youth and young adults. A report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

Chen, H.-H., & Yeh, M.-L. (2006). Developing and evaluating a smoking cessation program combined with an Internet-assisted instruction program for adolescents with smoking. *Patient Education and Counseling*, **61**(3), 411–418. doi:10.1016/j.pec.2005.05.007

Civljak, M., Sheikh, A., Stead, L. F., & Car, J. (2013). Internet-based interventions for smoking cessation. *Cochrane Database Systematic Review*, **7**. Article No. CD007078. doi:10.1002/14651858.CD007078.pub4

Conn, V. S., Isaramalai, S., Rath, S., Jantarakupt, P., Wadhawan, R., & Dash, Y. (2003). Beyond MEDLINE for literature searches.*Journal of Nursing Scholarship*, **35**(2), 177–182. doi: 10.1111/j.1547-5069.2003.00177.x

Crutzen, R., de Nooijer, J., Brouwer, W., Oenema, A., Brug, J., & de Vries, N. K. (2011). Strategies to facilitate exposure to Internet-delivered health behavior change interventions aimed at adolescents or young adults: A systematic review. *Health Education & Behavior*, **38**(1), 49–62. doi:10.1177/1090198110372878

Evers, K. E., Paiva, A. L., Johnson, J. L., Cummins, C. O., Prochaska, J. O., Prochaska, J. M., . . . Gökbayrak, N. S. (2012). Results of a transtheoretical model-based alcohol, tobacco and other drug intervention in middle schools. *Addictive Behaviors*, **37**(9), 1009–1018. doi:10.1016/j.addbeh.2012.04.008

Hutton, H. E., Wilson, L. M., Apelberg, B. J., Tang, E. A., Odelola, O., Bass, E. B., & Chander, G. (2011). A systematic review of randomized controlled trials: Web-based interventions for smoking cessation among adolescents, college students, and adults. *Nicotine & Tobacco Research*, **13**(4), 227–238. doi: 10.1093/ntr/ntq252

Madden, M., Lenhart, A., Duggan, M., Cortesi, S., & Gasser, U. (2013). *Pew Research Internet Project*. Washington, DC: Pew. Retrieved from http://www.pewinternet.org/2013/03/13/main-findings-5/

Mermelstein, R., & Turner, L. (2006). Web-based support as an adjunct to group-based smoking cessation for adolescents. *Nicotine & Tobacco Research*, **8**(Suppl. 1), S69–S76. doi: 10.1080/14622200601039949

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Medicine* **6**(6): e1000097. doi:10.1371/journal.pmed1000097

Norman, C. D., Maley, O., Li, X., & Skinner, H. A. (2008). Using the Internet to assist smoking prevention and cessation in schools: A randomized, controlled trial. *Health Psychology*, **27**(6), 799. doi: 10.1037/a0013105

Patten, C. A., Croghan, I. T., Meis, T. M., Decker, P. A., Pingree, S., Colligan, R. C., … Gustafson, D. H. (2006). Randomized clinical trial of an Internet-based versus brief office intervention for adolescent smoking cessation. *Patient Education and Counseling*, **64**(1–3),249–258. doi:10.1016/j.pec.2006.03.001

Shegog, R., McAlister, A. L., Hu, S., Ford, K. C., Meshack, A. F., & Peters, R. J. (2005). Use of interactive health communication to affect smoking intentions in middle school students:

A pilot test of the "Headbutt" risk assessment program. *American Journal of Health Promotion*, **19**(5), 334–338. doi: http://dx.doi.org/10.4278/0890-1171-19.5.334

U.S. Department of Health and Human Services. (2012). *Preventing tobacco use among youth and young adults: A report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

West, S., King, V., Carey, T. S., Lohr, K. N., McKoy, N., Sutton, S. F., & Lux, L. (2002, April). Systems to rate the strength of scientific evidence. *Evidence Report/Technology Assessment No. 47*. (Prepared by the Research Triangle Institute–University of North Carolina Evidence-based Practice Center under Contract No. 290-97-0011.) *AHRQ Publication No. 02-E016*. Rockville, MD: Agency for Healthcare Research and Quality.

Woodruff, S. I., Conway, T. L., Edwards, C. C., Elliott, S. P., & Crittenden, J. (2007). Evaluation of an Internet virtual world chat room for adolescent smoking cessation. *Addictive Behaviors*, **32**(9), 1769–1786. doi:10.1016/j.addbeh.2006.12.008