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Review article

Interventions Using New Digital Media to Improve Adolescent Sexual Health: A Systematic Review

Kylene Guse, M.A.[a], Deb Levine, M.A.[b], Summer Martins, M.P.H.[a], Andrea Lira, M.H.S.[b], Jenna Gaarde[b], Whitney Westmorland[c], and Melissa Gilliam, M.D., M.P.H.[a,*]

[a] *Section of Family Planning and Contraceptive Research, Department of Obstetrics and Gynecology, The University of Chicago, Chicago, Illinois*
[b] *Internet Sexuality Information Services, Inc. (ISIS), Oakland, California*
[c] *The College, The University of Chicago, Chicago, Illinois*

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A B S T R A C T

New digital media (e.g., the Internet, text messaging, and social networking sites [SNS]) have dramatically altered the communication landscape, especially for youth. These communication platforms present new tools for engaging youth in sexual health promotion and risk reduction. We searched eight public databases across multiple disciplines for all peer-reviewed studies published between January 2000 and May 2011 that empirically evaluated the impact of digital media-based interventions on the sexual health knowledge, attitudes, and/or behaviors of adolescents aged 13–24 years. Of 942 abstracts, 10 met inclusion criteria. Seven studies were conducted in the United States. Eight described Web-based interventions, one used mobile phones, and one was conducted on an SNS. Two studies significantly delayed initiation of sex, and one was successful in encouraging users of an SNS to remove sex references from their public profile. Seven interventions significantly influenced psychosocial outcomes such as condom self-efficacy and abstinence attitudes, but at times the results were in directions unexpected by the study authors. Six studies increased knowledge of HIV, sexually transmitted infections, or pregnancy. This area of research is emerging and rapidly changing. More data from controlled studies with longer (>1 year) follow-up and measurement of behavioral outcomes will provide a more robust evidence base from which to judge the effectiveness of new digital media in changing adolescent sexual behavior.

IMPLICATIONS AND CONTRIBUTION

New digital media provide innovative platforms for sexual health interventions among adolescents. There are few published studies evaluating the impact of these programs on youth knowledge, attitudes, and behaviors. Studies with longer follow-up and measurement of behavioral outcomes will strengthen this emerging body of research.

New digital media—for example, text messaging, Rich Site Summary feeds, and Web-based platforms, including social networking sites (SNS), shareable video sites, and wikis—have dramatically changed communication for people worldwide. These changes are particularly apparent for youth, both in the United States and abroad. The vast majority of Internet pages are published in English (http://www.internetworldstats.com/stats7.htm) and are accessed by users all over the world. In 2008, those aged 10–19 years accounted for the highest percentage (35%) of China's 298 million Internet users, followed by those aged 20–29 years at 32% [1]. In the United States, 93% of adolescents use the Internet, accessing the Web via personal and public computers, as well as mobile phones. Seventy-five percent of U.S. adolescents own a personal mobile phone [2]. In South Africa, only 6% of youth report daily Internet use, but 72% own mobile phones and 59% report using them daily [3]. As more youth are "wired," new digital media may provide a means of communicating with youth who have hitherto had poor access to electronic information.

This increase in and variety of communication tools may provide an important opportunity for health education and health promotion in general and sexuality education in particular. The Internet and other forms of digital media have afforded opportunities for the breakdown of geographic boundaries in sexuality education. New digital media can be disseminated

* Address correspondence to: Melissa Gilliam, M.D., M.P.H., Department of Obstetrics and Gynecology, The University of Chicago, 5841 S. Maryland Avenue MC 2050, Chicago, IL 60637.
E-mail address: mgilliam@babies.bsd.uchicago.edu (M. Gilliam).

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widely throughout the world, customized for particular communities and populations, and used privately, thus giving opportunities for self-directed learning.

Indeed, many sexuality education programs have used Web sites, SNS, and text messaging to educate youth. One literature review about the uses of mobile phone text messaging in sexual health has already been published [4]. To date, however, there has been no systematic review that includes various forms of interactive digital media, asking comparative questions about whether these types of interventions are capable of changing adolescents' sexual health knowledge, attitudes, and behaviors [5].

The purpose of this review is to summarize the currently published evidence base on the effectiveness of new digital media-based sexual health interventions for adolescents aged 13–24 years. We review individual studies and make comparisons across programs with regard to their design, methodology, and impact on knowledge, attitudes, or behavior. Together, these findings may help researchers and educators design more effective programs using new digital media for adolescent populations, and define measurement standards of behavioral outcomes for sexuality education interventions using digital media.

Methods

Definition of "new digital media"

Terms like "new media," "social media," "Web 2.0," "technology," and "digital media" are often used interchangeably by study authors, implying a collective understanding of their definitions. For this review, we have adapted a definition of "new media" found on the http://AIDS.gov Web site (http://aids.gov/using-new-media/basics/what-is-new-media/). Thus, we define "new digital media" as user-driven interactive forms of communication. Popular forms of new digital media include text messaging, SNS, Web sites, electronic mail (e-mail), Rich Site Summary feeds, blogs, podcasts/vodcasts, chat rooms, online videos, wikis, and virtual worlds. In other words, we emphasize the "shareability" and "interactivity" that new digital media provides, regardless of platform.

Literature search

We searched for all studies published in the English-language peer-reviewed literature from January 2000 through May 2011 providing evaluations of sexual health interventions that used new digital media platforms to reach adolescents. Relevant databases and search terms were identified with the help of a university librarian. Searches were performed in eight public research databases: Academic Search Premier, Child Development & Adolescent Studies, CINAHL, ERIC, PsychINFO, PubMed, Scopus, and Social Work Abstracts. Owing to the lack of convention regarding terms to describe new digital media, our search strategy was purposefully broad to ensure that we captured all relevant articles. Each database was searched by combining terms from each of three conceptual categories: new digital media (digital media, social media, Internet, Web, text messag*, technology, cell* phone*, mobile, computer*, e-mail, video gam*, gaming, software, blog*), adolescents (adolescen*, teen*, young adult*, youth), and sexuality education or sexual health (sex* education, sexual behavior, sexually transmitted infection*, HIV, condom*, contraception). We used database-specific indexing terms (e.g., MeSH in PubMed) whenever possible, supplementing them with other words and phrases as needed. We also examined the reference lists of identified articles to find studies that did not initially appear in our search. Finally, we contacted leading researchers in the field to inquire whether new evaluations had been conducted.

Inclusion and exclusion criteria

Studies were included if (1) participants aged 13–24 years comprised at least 50% of the study sample, or (2) analyses were stratified to present results specific to this age range. Additionally, studies had to empirically evaluate the impact of interventions on the sexual health knowledge, attitudes, or behaviors of youth. Therefore, we excluded studies that solely described the content, feasibility, or acceptability of programs without evaluating their direct impact on outcomes among youth. Eligible studies measured outcomes within the following domains: sex, reproduction, sexually transmitted infections (STIs), HIV, condoms, and contraception. We did not further restrict inclusion criteria, as we wanted to capture a broad range of outcomes in a recent body of literature.

Data extraction and synthesis

The lead author (K.G.) screened the titles and abstracts of all studies identified through the search strategy and excluded studies based on study population (e.g., older than 24 years) and design (e.g., literature review or case study). If eligibility was unclear based on the information provided in the abstract, the study was retained for further evaluation. The lead author and an additional author (W.M.) independently reviewed the full text of the remaining studies to confirm their eligibility for inclusion. Rare discrepancies were resolved through discussion, involving additional authors where necessary, with the lead author making the final decision. After a comprehensive review of the articles, the authors worked collaboratively to extract key information for compilation in an evidence table. We considered the setting, methodology, and analytical techniques of the studies, as well as the components of their interventions. We included only those findings relevant to adolescents with regard to changes in their sexual health knowledge, attitudes, and/or behaviors. Preference was given to adjusted, over unadjusted, estimates when both types were provided. Findings pertaining to feasibility, usability, and accessibility are not featured in the table but are discussed in the Results section.

Results

Execution of the search strategy yielded 942 unique publications. Screening of titles and abstracts eliminated 870. After reviewing the full text of the remaining 72 articles, we identified 10 that met all inclusion criteria (Table 1).

Study features

Population. Participants were mostly recruited from educational or health care settings: both colleges and high schools (n = 1), high schools (n = 2), middle schools (n = 2), clinics or service agencies (n = 3), both clinics and online (n = 1), and online only (n = 1). Two of the interventions were delivered to adolescents in rural settings: Chuxiong Prefecture in China [15] and Appala-

Table 1
Characteristics and findings of studies meeting review criteria (n = 10)

Author, year	Study population	Study design and theory	Intervention	Outcome measures and analysis	Results
Bull et al., 2009 [6]	United States n = 1565 Aged 18–24 years Internet sample (n = 991): 53% male, 66% white, 19% Asian. Recruited from Web sites or self-referred. Clinic sample (n = 574): 78% female, 70% white, 11% Hispanic. Seeking reproductive health services and recruited by clinic staff	Two RCTs: randomization to intervention and control groups within Internet and clinic samples SCT, TPB, TRA	Web-based: *Keep It Real*. Used Adobe Flash technology with pictures and audio (voice and music). Intervention: five question modules about HIV risk interspersed with role model stories matched to participants' gender and race/ethnicity. Stories addressed condom attitudes, norms, self-efficacy, and perceived HIV/STI risk. Delivered online to both samples; clinic sample used computer kiosk. Control: Same modules interspersed with text-based generic HIV prevention information.	Outcomes: • Change in proportion of sex acts protected with condoms • Condom-related constructs: Norms, outcome expectancy, self-efficacy for negotiation, self-efficacy for use Measurement: Baseline and 2 (Internet) or 3 (clinic) months Analysis: Repeated-measures structural equation models	Internet: Indirect effect on condom use. Small, but significant, impact on condom norms (standardized path coefficient = .06), which explained 42% of variance in condom use. Clinic: Statistically significant negative effect on self-efficacy for condom use (standardized path coefficient = −.10). No impact on condom use.
Halpern et al., 2008 [7]	Kenya and Brazil n = 1892 High school students Kenya (n = 1,178): Mean age = 16.5 years; 39% female Brazil (n = 714): Mean age = 14.7 years; 54% female	Quasi-experimental Schools assigned to "web" and comparison groups	Web-based: *TeenWeb*. Designed by African and Brazilian youth and youth experts. Web schools: Provided with Internet access, computer hardware/software, and privacy cubicles. Students completed five Web-based modules on sexual health (sexuality, contraception, abortion law, partner violence, HIV testing) and substance use followed by 30 minutes of Internet access (could browse project site or others). Comparison schools: Received electronics but no Internet access.	Outcomes: • Knowledge about EC and abortion law • Perceived barriers to condom use, norms of condom use, and perceptions of condom effectiveness in preventing HIV and pregnancy • Perceived difficulty in getting free and confidential HIV testing Measurement: Baseline and 18 months Analysis: Logistic regression controlling for age, gender, SES, baseline scores, and clustering by school	Most differences in knowledge/attitudes between intervention and comparison groups were statistically significant, but only about half of associations were in intended direction within both cities. Associations in intended direction were small and post-test scores still low.
Lou et al., 2006 [8]	China n = 624 (intervention) n = 713 (control) 55% male Students from two high schools (equivalent to U.S. tenth grade) and four colleges of science and engineering	Quasi-experimental Assigned one high school and two colleges to each group (intervention and control)	Web-based: http://www.youthhood.com.cn. Designed with youth input and updated every 2 weeks. Intervention group self-directed through: 1. > 200 Web pages covering broad range of sexual and reproductive health topics 2. Ten 10-minute educational videos with reproductive health content 3. Professional counseling by e-mail 4. Discussion of sex-related issues on a BBS moderated by research staff Control group did not receive any specially designed sexual health curriculum.	Outcomes: • Knowledge of reproduction, contraception, condoms, STIs, HIV (composite score from 98 items) • Permissiveness toward premarital sex and contraceptive use (composite score from eight items) • Sexual behaviors (hugging, kissing, petting, intercourse) Measurement: Baseline and 10 months Analysis: Ordinal (knowledge, attitudes) or binary (behavior) logistic regression models	Statistically significant increase in all unadjusted knowledge (total and area) scores among male and female subjects. Largest impact was on knowledge of reproduction (adjusted OR = 2.85, $p < .0001$). Small, but statistically significant, impact on attitudes (making them more conservative) among high school students (adjusted OR = .63, $p < .05$); no impact in college sample. No statistically significant effects on behaviors.

Table 1
Continued

Author, year	Study population	Study design and theory	Intervention	Outcome measures and analysis	Results
Markham et al., 2009 [9]	United States n = 32 Aged 13–24 years; Mean = 17.8 63% female, 69% black, 28% Hispanic Convenience sample of HIV-positive youth recruited from clinics or service agencies	Single-arm pilot study Motivational enhancement therapy, SCT, self-regulation theory	Web-based: *+CLICK*. Adobe Flash-based with animation, interactive activities, and video. Adapted from *It's Your Game, Keep It Real* [10]. Users accessed Web site during clinical or service encounter. Entered demographic, behavioral, and attitudinal data (pretest) that generated tailored activities based on user's risk profile.	Outcomes: • Perceived importance and self-efficacy regarding (1) abstinence (not initiating or resuming sex), and (2) condom use. Measurement: immediately after intervention Analysis: Wilcoxon signed-rank test	Statistically significant increase in condom self-efficacy ($p = .008$). Borderline significant ($p = .07$) increases in perceived importance of and self-efficacy for abstinence.
Marsch et al., 2011 [11]	United States n = 56 Aged 12–18 years Standard condition (n = 28): 71% male, 68% black, 29% Hispanic Enhanced condition (n = 28): 68% male, 50% black, 39% Hispanic Entering outpatient treatment for substance abuse	RCT	Web-based, including interactive exercises, animation, and videos. Standard: 1-hour session led by HIV/STI/hepatitis prevention educator (disease transmission, risk reduction, correct condom use, testing). Enhanced: Same 1-hour session plus self-directed Web-based program with 25 modules on HIV/STI/hepatitis (basic disease info, substance abuse as risk factor, risk reduction, and relevant skills). Users completed assessment to receive suggestions for modules and order based on their risk profile.	Outcomes: • HIV/disease prevention knowledge • Intention to use condoms • AIDS risk reduction scale (sexual self-efficacy and condom attitudes) • Condom use skills Measurement: immediately and 1 and 3 months after intervention Analysis: Fisher least significant difference procedure	Immediate increase in HIV/disease prevention knowledge after intervention over standard condition that was maintained at all follow-up points ($p = .001$). Significant increases in both groups seen for condom intentions, condom skills, and most items in AIDS risk reduction scale. No difference by condition, except for increase in perceived importance of carefully choosing sex partners in enhanced group ($p = .03$).
Moreno et al., 2009 [12]	United States n = 190 (95 in each group) Aged 18–20 58% male, 52% black, 12% white MySpace users with public profiles displaying three or more references to sexual behaviors or substance use. Resided in zipcode randomly selected from a list of the 10 lowest-income urban areas defined by U.S. census	RCT	Social networking site: http://www.MySpace.com Intervention: Received one e-mail from female physician's MySpace profile advising user on risk of disclosing sex/substance behaviors on their public profile. Also provided link to STI testing resources. Control: No contact from researchers.	Outcomes: • Removal of MySpace sex references • Removal of MySpace substance abuse references • MySpace profile security set to private. Any of above changes Measurement: Baseline and 3 months using content analysis Analysis: Logistic regression with adjustment for demographic and baseline risk variables	Intervention group more likely to remove references to sex (adjusted OR = 4.2) and make any protective change (adjusted OR = 1.9).
Puccio et al., 2006 [13]	United States n = 8 Aged 16–24 years 88% male, 50% Hispanic, 25% black, 13% white Convenience sample of HIV-positive patients starting HAART	Single-arm pilot study	Mobile phone. Participants received a free phone with 250 "anytime" minutes and free nights/weekends. Received reminder calls from research team daily (first 4 weeks), on weekdays only (weeks 5–8), or on 3 days of the week (weeks 9–12) at the time chosen by the participant. Reminders terminated for patients who missed more than three calls.	Outcomes: • Missed medication doses • Viral load • Missed calls Measurement: 4, 8, 12, and 24 weeks	Very few missed calls and medication doses when reminders were daily. Viral load generally decreased in accordance with adherence to phone calls and medication. Two patients left the study with major medical problems and/or relapses into substance abuse

Table 1
Continued

Author, year	Study population	Study design and theory	Intervention	Outcome measures and analysis	Results
Roberto et al., 2007 [14]	United States n = 139 (intervention) n = 187 (control) 56% female, 97% white Tenth graders at two rural high schools in same county (mean age = 15 years)	RCT (one school randomized to each group) Extended parallel process model, transtheoretical model, TPB, TRA	Web-based plus CD-ROM. Most activities reproduced on paper for students without Internet access. Intervention: Six self-directed computer-based activities completed outside of class time over 7 weeks. One activity was online for first 6 weeks and all were put online during week 7. Addressed knowledge, attitudes, and skills related to prevention of pregnancy and HIV/STIs. Included "choose your own adventure" CD-ROM and radio PSA contest activities. Control: Not described.	Outcomes: • Knowledge of HIV/STIs and pregnancy prevention • Condom negotiation skills and self-efficacy • Attitudes toward waiting to have sex • Perceived susceptibility to negative consequences of sexual activity • Situational self-efficacy and refusal self-efficacy • Initiation of sex and number of sexual partners Measurement: 2 weeks before intervention (T1) and 10 weeks after (T2) Analysis: Mixed-model, 2-way repeated-measures ANOVA	Intervention group had statistically significant increases vs. control in four areas: knowledge, condom negotiation skills, abstinence attitudes, and situational self-efficacy. Significant increase in perceived susceptibility measure among control vs. intervention ($p < .01$). Intervention effective at delaying initiation of sex for students sexually naive at T1 (OR = 2.93, $p < .01$). For students sexually active by T2, intervention associated with borderline significant decrease in number of sex partners ($p = .055$).
Tian et al., 2007 [15]	China n = 1,357 Eighth graders (95% aged 13–15 years) 52% male, ~60% Han, 40 ethnic minorities Residents of three townships selected from each of three study counties	RCT Three counties randomized to one of two experimental conditions or control	Web-based Web site created that contained 52 programs addressing HIV/STIs that changed weekly. Participating organizations (POs) at each county charged with disseminating information from Web site to local students via classrooms and routine interactions. POs included local public health bureaus, departments of education, and Women's Federation. County 1: POs received computers, computer skill training, workshop on information diffusion practices, logistic support every 6 weeks County 2: POs received computers with logistic support as requested County 3: No intervention	Outcomes: • Knowledge of HIV and hepatitis B (16 items) Measurement: Surveys at baseline and 1 year after Web site debut Analysis: χ^2 (item scores), Student t test (mean scores), and GLM (change in mean scores between counties and time points)	Students in both intervention counties had significant increases in mean knowledge scores (21.5% in county 1 and 8.7% in county 2) vs. baseline ($p < .01$) and county 3 ($p < .0001$), whose score was stable. Scores in county 1 significantly higher than county 2 on nine items. Both intervention counties had higher scores on many items vs. county 3, but county 1 had larger effect.
Tortolero et al., 2010 [10]	United States n = 558 (intervention) n = 349 (control) Seventh and eighth graders (mean age = 13 years) 59% female, 42% black, 44% Hispanic, >90% receiving free/reduced-cost lunch	RCT 10 schools randomized to intervention (n = 5) or control (n = 5) SCT, social influence models, and theory of triadic influence	Web-based: *It's Your Game: Keep It Real.* Developed with teen advisory board. Intervention: Computer component featured virtual world interface, educational activities tailored to gender and sexual experience, and real-world scenarios with online feedback and discussion. Other components: Twenty-four 45-minute structured group lessons, 12 parent–child homework activities, and journaling. Content covered life skills, healthy friendships, healthy romantic relationships, setting limits, refusal skills, general reproductive health knowledge, HIV/STI/pregnancy testing, condom skills, and contraception skills.	Outcomes: • Delayed sexual initiation (vaginal, oral, anal) among those reporting no sex at baseline • Reduced risk behavior for sexually active students • Psychosocial measures specific to underlying theory for intervention Measurement: ACASI survey at baseline and seventh, eighth, and ninth grades	Students in control group significantly more likely to initiate oral (adjusted RR = 1.76) and anal (adjusted RR = 2.67) but not vaginal sex Vaginal sex: Hispanics were only race/gender subgroup with significantly increased risk in control group (adjusted RR = 1.67)

Table 1
Continued

Author, year	Study population	Study design and theory	Intervention	Outcome measures and analysis	Results
			Control: Standard health classes, varied by school	Analysis: Changes from baseline to ninth grade (~24 months) using multivariate regression models	Subgroup analyses: Control condition associated with increased risk of initiating oral sex among blacks (adjusted RR = 1.84) and female subjects (adjusted RR = 2.14), and of initiating anal sex among blacks, male subjects, and female subjects (adjusted RR 2.3–3.9) Controls had significantly higher frequency of vaginal sex in past 3 months ($p < .05$). Significant impact on many intermediate psychosocial outcomes, but effects diminished between eighth and ninth grade.

ACASI = audio-computer-assisted self-interview; BBS = bulletin board system; EC = emergency contraception; HAART = highly active antiretroviral therapy; RCT = randomized controlled trial; SCT = Social Cognitive Theory; TPB = Theory of Planned Behavior; TRA = Theory of Reasoned Action; SES = socioeconomic status.

chian high schools in the United States [14]. Two of the interventions enrolled HIV-positive youth [9,13], and one enrolled youth with substance use disorders [11]. Seven of the 10 study populations were based in the United States.

Study design. Sample sizes ranged from <50 participants to almost 1,900; four of the studies had >1,000 participants. Six studies were randomized controlled trials (RCTs), two used a quasi-experimental design, and two were single-arm noncomparative pilot studies. Six [7–10,13,14] of the 10 studies mentioned incorporating youth input in the design of their interventions. For example, Tortolero et al. [10] formed a teen advisory board that built community support and provided formative guidance in the development of the curriculum.

Theory. Four studies [6,9,10,14] described behavioral theories that served as the basis of their interventions. Social Cognitive Theory (SCT) [16] was most commonly mentioned and was often used in combination with others. Drawing from SCT, the Theory of Reasoned Action [17], and the Theory of Planned Behavior [18], Bull et al. [6] designed their program to impact factors that precede condom use. Roberto et al. [14] incorporated concepts from the extended parallel process model [19], transtheoretical model [20], the Theory of Reasoned Action, and the Theory of Planned Behavior to craft an intervention addressing adolescents' perceived susceptibility, severity, response efficacy, and self-efficacy regarding condom use and abstinence. The online intervention, *It's Your Game: Keep It Real* [10], which was adapted for *+CLICK* [9], was grounded in SCT, social influence models [21], and theory of triadic influence [22]. Both interventions also incorporated the life skills decision-making paradigm, *Select, Detect, Protect*, which is based on self-regulation theory [23] and teaches students to set personal limits and then use refusal skills and other tactics to maintain their limits.

Follow-up and attrition. The follow-up period of the evaluations ranged widely from immediately after intervention to 2 years. Interestingly, one program that recruited participants both online and in clinics altered the timing of their follow-up according to recruitment mechanism [6]. The Internet sample was asked to complete a follow-up risk assessment at 2 months, whereas the clinic sample completed their assessment at a 3-month interval more commonly used in health research. According to the authors, this approach was used to "avoid precipitous attrition at three months as seen in other research conducted with people recruited exclusively on the Internet." Attrition rates in the 11 studies ranged from 3% to 57%, mostly depending on the length of follow-up. The lowest attrition rates were seen among college students [8]. High attrition rates were attributed to the difficulty of retaining samples in online studies and high rates of mobility and school dropout in studies that were conducted in low-income areas [6,10]. In none of the studies, however, was attrition reported to significantly bias the results.

Outcome measures. Six studies reported on outcomes pertaining to youth behaviors, including initiation of vaginal sex [10,14], recent sexual intercourse [8,10], frequency of sex [10], number of sexual partners [10,14], condom use [6,10], and sex while under the influence of drugs or alcohol [10]. Tortolero et al. [10] additionally considered the initiation, frequency, and number of sexual partners for specific types of sex—vaginal, oral, and anal. Other behavioral outcomes included adherence to medication

among young HIV-positive participants [13] and alterations to public profiles on an SNS [12]. Seven [6–11,14] of the studies reported on psychosocial outcomes, most commonly related to condoms—for example, self-efficacy, perceived importance, perceived effectiveness, negotiation skills, intentions to use, opinions, and preferences. Attitudes and intentions regarding sexual abstinence were measured in four studies [8–10,14]. Six of the studies evaluated knowledge-based outcomes pertaining to HIV/STIs [8,10,11,14,15], condoms [8,11], reproduction [8], emergency contraception [7], and abortion law [7]. Only one study evaluated a biological outcome: viral load among HIV-positive youth on highly active antiretroviral therapy (HAART) [13].

Program characteristics

Incorporation of new digital media. The majority (n = 8) of studies used the Internet as a platform for the intervention. Lou et al. [8] examined the effectiveness of a Web site for youth in Shanghai, China, that included online videos, a bulletin board system, and an expert e-mail box. In the Youthnet trials [6], participants were directed to the *Keep It Real* Web site, where they responded to questions related to their HIV risk. Between question sets, participants were exposed to a role model story that was matched to their gender and race/ethnicity and delivered using Adobe Flash technology with pictures and audio. The Web-based *+CLICK* [9] was developed in Adobe Flash and included animation, interactive activities, and videos featuring peers and experts. Marsch et al. [11] described an interactive, customizable, Web-based program that supplemented a face-to-face educator-delivered session. Because this program was browser based, it had the ability to be delivered via the Internet, Intranet, or CD-ROM, and the authors noted that key intervention components could be delivered on mobile devices. The remaining Web-based studies did not provide more detailed information on how they incorporated specific forms of new digital media. One study used mobile phone calls to remind HIV-positive youth to take their prescribed HAART medication [13]. Another intervention designed to reduce sexual risk behaviors sent a cautionary message on the SNS MySpace from a fictional physician profile ("Dr. Meg") to public profiles of those aged 18 and 19 years that displayed references to sex and substance abuse [12].

Duration and intensity. Interventions varied widely in length and intensity. The shortest program was a single e-mail [12] and the longest consisted of 24 × 45-minute sessions administered over 2 years [10]. Some programs were administered in a way that standardized intervention exposure among participants [6,7,9,10,12,13], whereas in other studies, intervention activities were self-directed [8,11,14,15].

Content. The content of most interventions covered basic information such as HIV/STI transmission dynamics, testing for HIV/STIs and pregnancy, reproduction and pregnancy, and risk reduction strategies, including contraceptive use, condom use, and avoidance of drugs and alcohol. Four [8–10,14] programs addressed participants' skills in areas such as condom use, contraceptive use, and refusing sex. Some interventions took a comprehensive approach to sexual health and included content on subjects like intimate partner violence [7], personality traits associated with general risk taking [14], healthy friendships [10], and healthy dating relationships [10].

Activities. In five studies, activities were tailored to participants by gender [6,9,10], by race/ethnicity [6], and according to their risk profile [9–12]. Four interventions included question/answer "quiz" modules to gauge participants' sexual health knowledge and perceptions [6,7,10,14]. Role model stories [6,10,11] and videos featuring peers or experts [8–10] were also commonly included. Other activity types included moderated online discussion [8,10], contact by health professionals over e-mail [8,12], self-assessment of skills and attitudes [14], and mobile phone calls from research staff [13]. Three studies [9,11,15] mentioned using activity modules or programs with no further detail as to what they contained. In three studies, Web-based activities were supplemented with more conventional educational approaches, including classroom instruction [10], small-group sessions [11], and a CD-ROM-led exercise [14].

Findings

Three studies showed statistically significant impacts of interventions on youth behaviors. Roberto et al. [14] found that tenth graders in the control group were almost three times as likely to initiate sex by 10 weeks after intervention (odds ratio [OR] = 2.93, $p < .01$). Middle school participants of *It's Your Game* were significantly less likely to initiate oral and anal sex by the ninth grade [10]. Although the intervention did not impact initiation of vaginal sex in the study population as a whole, subgroup analyses revealed a significantly increased risk among Hispanics in the control group (adjusted relative risk = 1.67, 95% confidence interval [CI] = 1.02–1.64). MySpace users who received an electronic message from a physician were significantly more likely to make a protective change to their public profile (adjusted OR = 1.9, 95% CI = 1.0–3.5), including removing references to sex (adjusted OR = 4.2, 95% CI = 1.3–14.2) [12]. Authors of the fourth study [6] found an indirect effect of their intervention on a behavioral outcome: among participants recruited online, there was a very small, but significant, impact of their intervention on condom norms (standardized path coefficient = .06), which in turn explained 42% of the variance in participants' condom use. Finally, frequent reminder calls seemed to improve HAART adherence among HIV-positive youth, but the authors were unable to conduct significance testing owing to the small sample size (n = 8) [13].

Seven interventions were seen to significantly impact psychosocial outcomes, but at times the results were not in the expected direction. Of the four studies evaluating self-efficacy for condom use, one [9] found a statistically significant positive effect, one [6] noted a statistically significant negative impact, and two [10,14] found no intervention effects. Among tenth graders attending rural high schools, students exposed to the intervention had significantly higher condom self-efficacy, more positive attitudes toward abstinence, and greater perceived susceptibility to the negative consequences of sex; however, they also reported significantly lower perceived susceptibility to HIV/STIs and pregnancy at the 10-week follow-up [14]. Tortolero et al. [10] saw significantly positive effects on participants' beliefs about remaining abstinent until marriage and their perceptions of friends' sexual behavior and condom beliefs. At the same time, no intervention effects were seen for many other psychosocial measures, including intention to engage in various types of sex and remain abstinent through high school. In their study of Brazilian and Kenyan youth, Halpern et al. [7] found four of 14 condom-related measures to be significantly impacted in both

sites, but effects were either in opposite or in unexpected directions. Teens randomized by Marsch et al. [11] to receive a Web-based intervention showed significant gains from baseline in four of 13 psychosocial variables related to safer sex, but when compared with teens receiving standard HIV education, the increases were only significant for one of the measures.

All six studies that evaluated program impact on knowledge-based measures noted statistically significant effects, mostly in the areas of HIV and STIs. Halpern et al. [7] demonstrated significant increases in three emergency contraception knowledge items among Kenyan participants, but significant decreases were found in the Brazilian sample on two of the same measures. Youth in Lou et al's intervention had significant ($p < .05$) gains in knowledge in all five areas evaluated (reproduction, contraception, condoms, STIs, and HIV/AIDS) but showed no reductions in behaviors (hugging, kissing, petting, or sexual intercourse) [8].

Finally, attitudes toward the interventions themselves were usually positive. Marsch et al. [11] found that participants perceived the addition of a Web-based program as more useful than a 1-hour educator-delivered intervention. The HIV-positive youth who participated in *+CLICK* indicated that they were very likely to use it again [9]. Participants of the intervention described by Roberto et al. [14] had very favorable impressions of the "truth or myth" activity but gave low ratings to the radio PSA. Finally, Puccio et al. [13] noted that respondents in their 12-week intervention program found mobile phone call reminders to be helpful and unobtrusive.

Discussion

Collectively, the studies reviewed here provide insight into the potential of new digital media for sexuality education. First, the studies considered use a wide range of approaches to intervention. Although most are Web-based, other modalities are also used, such as mobile phones, SNS, online video, bulletin board discussions, expert e-mail, and gaming. Second, new digital media can be tailored to the audience. For example, *+CLICK* [9] allows youth to enter data about themselves to create a personal profile that then drives the tailoring functions. As youth are at varying cognitive stages, have different levels of sexual experience, and have varying knowledge gaps, the adaptability of these interventions is particularly important. Third, these studies target a wide range of sexual and reproductive health behaviors, including sexual initiation, use of social media sites, and adherence to medication.

It is also notable that the interventions reach diverse populations of youth. Much attention has been focused on disparities in access to digital media and the potential for those with less access to miss out on technology-based opportunities [24]. Here we see interventions that focus on low-income urban youth, HIV-positive youth, youth with substance use disorders, and young people in China, Africa, and Brazil. Our search strategy identified additional studies that, although not meeting inclusion criteria for this review, successfully engaged men who have sex with men [25–28] and youth of color [29,30]. Yet, there are limits to the claims of increased access. Tian et al. [15] experimented with tiers of technological intervention, supplying local organizations with computer equipment only or equipment plus support, and clearly showed that the addition of technological support and logistical help in diffusion of health information was needed to significantly improve students' knowledge of STIs. Similarly, many interventions were delivered in a school or a clinical setting that most likely provided a necessary technological infrastructure. Studies in which youth are provided mobile phones offer ideas for bridging gaps in access to technology.

There are a number of limitations to the current literature. Statistically significant impacts were most often seen on knowledge-based outcomes, which may not translate to meaningful reductions in youth risk behaviors. Measuring behavioral outcomes sets a high standard, entailing longer follow up and retention than most of these studies attempted. Notable exceptions include studies by Roberto et al. [14] and Tortolero et al. [10], both of which demonstrated significantly reduced risk of sexual initiation among high school students.

Our review raises a number of methodological issues to be considered in future research. First, some interventions were delivered in the schools, whereas others reached youth outside of formal educational settings. Some researchers have shown that in-school interventions can be limited by filters placed on Web sites to prevent examining sexual and reproductive health information, and some students may have limited access to Internet use at home [31]. Second, these studies highlight the roles and responsibilities of researchers when using new digital media for sexual health promotion, as well as best practices for entering youth-driven environments to learn from and with youth in ways that are engaging and empowering. For example, should young peoples' public SNS profile pages be subject to analysis or enrollment in an intervention to which they did not consent? Finally, the majority of studies reviewed were RCTs, the gold standard of study design and an important precedent for future research in this area. The RCT process, however, can be laborious, with timelines that are inconsistent with the paces of technology and youth culture. Perhaps alternative approaches to evaluation are needed, ones that are more aligned with the flexibility and adaptability of new digital media.

Our review has a number of strengths. We provide a systematic evaluation of peer-reviewed literature from a new area of research that has not been well described. Our focus on new digital media allowed us to capture a rich array of studies, behaviors, and audiences. Some limitations must also be noted. First, we subjected an emerging field to a detailed review. Until recent years, few studies were funded and few researchers were willing to risk working with the changing technology landscape and related research methodologies. However, a review can set baseline standards and help current and future researchers learn from the experience of their peers. Second, we adopted a specific definition of new digital media. One can argue that interventions that share characteristics with those in our included studies do not appear in this review—for example, CD-ROMs or computer program interventions. New digital media, as defined by us, is user controlled and shareable. Some of the reviewed studies demonstrate why these two properties are critical, as reaching a large population could magnify the effects of an intervention. Third, the review criteria may have resulted in the inclusion of studies that may not initially seem like new digital media. For example, we included a mobile phone-based intervention in which the phone was used for calling rather than for a text-message-based intervention. This particular study was included after much consideration by the research team, as we felt that emphasis on distributed mobile phones met our inclusion criteria, although one can argue that a call on a mobile phone is not user controlled or shareable. Fourth, we may have missed interventions in our research. We reviewed eight databases, the reference sections of all included articles, and studies from all over

the world. Nevertheless, we limited our search to the English-language peer-reviewed literature and set a specific cutoff date. As such, some studies that would have met the criteria for inclusion in this review were not included owing to the timing of preparing and publishing this manuscript.

New digital media for sexual health promotion is an emerging field. The rapid evolution of technology presents challenges for rigorous research studies of technology-based sexual health interventions for youth. The time spent in writing proposals, conducting trials, and disseminating results cannot stay apace of technological innovation. However, there are opportunities within this research to begin to understand the potential of tailored intervention components, the replicability and scalability of new digital media interventions, and the effectiveness of particular approaches based on delivery method, duration, and other variables. Some studies in our review also suggest how behavioral theories may inform new digital media interventions. Future research should consider the aspects of existing theories that are best suited for technology-based interventions, and whether new theories that address the unique affordances of new digital media (e.g., tailored interventions, peer-shared interventions) are needed. Lessons will also come from the increased use of digital media in other fields of medicine and health promotion. Ultimately, our review demonstrates that new digital media have tremendous potential to engage and support the sexual health of youth. Much like digital products themselves, the literature describing and evaluating new digital media will benefit from the processes of rapid dissemination and continuous updates.

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