



HHS Public Access

Author manuscript

Curr HIV/AIDS Rep. Author manuscript; available in PMC 2016 December 01.

Published in final edited form as:

Curr HIV/AIDS Rep. 2015 December ; 12(4): 500–515. doi:10.1007/s11904-015-0280-x.

Youth, Technology and HIV: Recent Advances and Future Directions

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Abstract

Technology, including mobile technologies and social media, offers powerful tools to reach, engage, and retain youth and young adults in HIV prevention and care interventions both in the United States and globally. In this report we focus on HIV, technology, and youth, presenting a synthesis of recently published (Jan 2014-May 2015) observational and experimental studies relevant for understanding and intervening on HIV risk, prevention and care. We present findings from a selection of the 66 relevant citations identified, highlighting studies that demonstrate a novel approach to technology interventions among youth in regard to content, delivery, target population or public health impact. We discuss current trends globally and in the US in how youth

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Conflict of Interest

L.B. Hightow-Weidman: Honorarium to speak for Gilead on unbranded topics, not product related; K.E. Muessig: none; J. Bauermeister: none; C. Zhang: none; S. LeGrand: grants from National Institutes of Health, substance abuse and mental health services administration, Kaiser Permanente.

Human and Animal Rights and Informed Consent

This article does not contain any studies with human or animal subjects performed by any of the authors.

are using technology, as well as emergent research issues in this field – including the need for new theories for developing technology-based HIV interventions and new metrics of engagement, exposure, and evaluation.

Keywords

mHealth; eHealth; internet; HIV; mobile phone; smartphone; social media; intervention; youth; adolescent; teen

Introduction

Worldwide, nearly a third of all new HIV infections occur among youth ages 15 to 24 years (1). Adolescents and young adults are often situated within a confluence of behavioral and developmental transitions that create higher risk contexts for HIV acquisition and suboptimal care. These transitions include onset of sexual activity and substance use, shifting roles with family and peers, adoption of adult roles and responsibilities, and exposure to systemic barriers to health care services (2-5). As a result, compared to older populations, youth are less likely to know their HIV status, be retained in care, and achieve viral suppression (6, 7). Youth also experience greater AIDS-related mortality than older cohorts (6).

Over 50% of the world's population is estimated to own mobile phones (8) and 42% use the Internet (9). However, across the globe, technology ownership and use among youth is higher. In the United States (US) in 2014, overall technology usage (including Internet and mobile phone use) among youth age 12 to 29 years was over 90%. Similarly, social media use is high among both younger (12-17 year olds: 81%) and older youth (18-29 year olds: 89%) (10). Internet access and social media use among youth living in low- and middle-income countries is increasing, but has not achieved the same market saturation as in high-income countries. For example, in recent samples, reports of mobile phone ownership range from 47% among urban Ugandan youth (11) to 90% among youth in Cape Town, South Africa (12).

Researchers have sought to understand the role of technology in youth's lives and to use it for HIV prevention and care purposes (13, 14). As the most avid and often earliest adopters of new technology, youth have a multifaceted relationship with technology (13). Technology provides powerful means through which to spread information, educate, and support youth (14-17). These same tools may also link youth to services, facilitate social support and community mobilization (18), and promote risk reduction norms (19). However, technology may also facilitate youth's exposure to behavioral (e.g., non-disclosure of HIV status to partners met online) or social (e.g., stigma, prejudice, bullying) risk factors (20). Content shared among youth on social networking sites and perceptions of peers' behaviors may also affect offline sexual risk intentions and behaviors (21-23). Furthermore, the intersection between legal age and technology use has developmental implications for HIV research. For example, the same behavior—online exchange of sexually explicit images or “sexting”—between a 13 and 24 year old person can be prosecuted as a crime, whereas it would be acceptable between two 21 year old adults.

In this report we focus on HIV, technology, and youth, presenting a synthesis of recent observational and experimental studies relevant for understanding and intervening on HIV risk, prevention, and care. We discuss current trends globally and in the US, as well as emergent issues in this field – including the need for new theories for developing technology-based HIV interventions and new metrics of engagement, exposure, and evaluation.

Methods

We sought to identify articles for this synthesis that were published in English between January 1, 2014 and May 1, 2015. Our target population was “youth” – defined broadly as ages 13 to 29. Studies with broader samples that stratified results by age were also eligible. Studies needed to include a primary focus on one or more of the following technologies: mobile phone (SMS/texting, application “app”), computer/tablet (stand-alone programs, web-based programs), or social media (e.g. Facebook, Twitter, Instagram). The following types of studies were reviewed: interventions (formative, usability, pilots, trials), observational studies, and reviews.

Search strategies and disposition of citations are presented in Figure 1. After reviewing the full text publications, 66 relevant records were identified, including 24 records from intervention studies. All intervention studies identified are presented in Table 1. In the body of this paper we highlight a subset of the 66 identified records that significantly extended prior work and/or presented novel methods or findings most pertinent to the field of technology for HIV prevention and care among youth.

Results

Use of technology and sexual risk

Recent studies have examined youth’s online sexual behaviors, use of technology to facilitate off-line sexual encounters, and sexual risks associated with these activities. Research suggests a relationship between online social networking and sexual risk behaviors among youth, though causality has not been established (20, 24-28). For example, among 1831 Los Angeles high school students, ages 12 to 18, youth who accessed the Internet by cell phone were more likely to be sexually active, to have been approached online for sex, and to have had sex with a partner met through the Internet. Compared to heterosexual students, bisexual students were more likely to be solicited online for sex while gay, lesbian, and questioning students were more likely to report seeking partners online and engaging in unprotected sex at last sexual encounter with a partner met online (29).

Research on the online sexual behavior of sexting among youth is rapidly increasing (30). “Sexting” combines the words “sex and texting” to describe sending sexually suggestive/explicit photos or messages via an electronic device such as a mobile phone. Between 9 and 48% of US youth report sexting (30, 31). Recent work conducted among middle school students (age 10-14) (25, 26, 32), high school students (age 15-18) (27, 31, 32), and young adults (age 18-24) (28, 31) indicates that sexting occurs concurrently with other sexual behaviors. A national online survey of 5078 youth (ages 13 to 18) of different sexual

orientations found that 18% had sexual conversations online and 7% shared sexual photographs online in the last year (33). Lesbian, gay and bisexual youth (including queer, questioning, and those with other identities) were more likely than their heterosexual peers to have sexual conversations and post sexual pictures online. Of the 22% of adolescents who were sexually active, 10% had met a recent sexual partner online (33). As the majority of studies have been cross sectional (see Temple et al. for an exception (27), the nature of the association between sexting and sexual risk behaviors has not been established. The majority of studies on sexting published in English have been conducted in the US, with notable exceptions from Peru (34) and Italy (35). Current limitations in this literature include variation in the definitions of sexting, lack of longitudinal studies, and lack of studies that include both the sext senders and receivers.

Another emerging body of research focuses on sexual risk and use of geosocial networking apps to find sex partners, in particular among YMSM (36-38). For example, among 146 randomly sampled YMSM, age 18 to 24, who reported having sex with partners met through Grindr, 20% had unprotected anal intercourse (UAI) with their most recent Grindr-met partner (37). Using Grindr for more than a year, posting sexualized photos and having more sexual partners met through Grindr in the past month were associated with reporting UAI (37). Among 379 MSM, age 19-73, in Washington, DC, 23.5% had sex with a partner met using geosocial networking apps in the past year; those under age 35 were more likely to report this behavior than those 35 or older (aOR 2.70, 95% CI 1.39, 5.22, $p < .01$) (38).

Outside of the US, a study conducted with 269 students ages 13-17 in Eastern Canada examined associations between online behaviors and sexual health outcomes; 59% had viewed Internet pornography, 29% had received and 14% had sent a nude or seminude photograph, 41% had talked about sex online, and 10% talked about sex online with a stranger. Outcomes related to sexual risk such as knowledge of sexually transmitted infections (STIs), consistency of condom and contraception use, and communication about sex with parents and sex partners were no different comparing those who participated in online sexual behaviors and those did not (39).

Among 3432 Swedish youth, age 16 to 22, only 15% reported finding a sex partner online, posting sexual photos or selling sex to a person met online (40). These behaviors were associated with problematic background, poorer self-rated health, reports of a more sexualized life, and sexual or physical abuse (40). A study of 4485 South African students, ages 12 to 20, examined associations between sexual risk behaviors and use of Facebook and Mxit, a mobile phone instant messaging app. Female Facebook users were more likely to report multiple sex partners, age disparate sexual partners (≥ 5 years older or younger), and hazardous alcohol use in the last year. Mxit use was associated with multiple sex partners and hazardous alcohol use among males and females in the last year (41). Among an online sample of 1342 MSM in China (23.6% age 16 to 25), 40.6% of participants had used apps to find sex partners, a behavior associated with younger age, report of multiple recent sexual partners, and recent HIV testing; no difference was found in UAI (42).

Acceptability of technology for sexual health promotion

Two recent US studies examined youth's use of technology to find sexual health information. In semi-structured interviews with 81 African-American heterosexual youth, ages 15 to 17, less than half used the Internet to find sexual health information; those that reported this behavior often described it in the context of school assignments or finding information surreptitiously after clicking on advertisements on social networking sites (43). An online survey among 5542 youth age 13 to 18 found that 19% of heterosexual youth versus 78% of gay/lesbian/queer youth used the Internet to search for sexual health information, a difference primarily attributed to sexual minority youth reporting lack of credible offline information sources (44).

Two studies examined young MSM (YMSM's) interest in participating in technology-delivered HIV prevention interventions. Among 6329 MSM ages 19 to 27 surveyed online, 49% of those who owned mobile phones were willing to receive text messages for HIV prevention (45). Important differences were noted by race/ethnicity (Black and Hispanic men more willing than White men), and education level and age (higher education and older age men less willing) (45). In the Los Angeles area, among a sample of 195 MSM ages 18 to 24 who use Grindr, 70% expressed interest in a future smartphone HIV-prevention intervention and 71% in an online-based intervention (36).

International settings also report high acceptability for technology use for sexual health. Among 620 Australian youth (age 16 to 29), 85% were comfortable getting sexual health information from websites, with somewhat lower levels for social media (Facebook, 52%; apps, 51%; SMS, 44%; Twitter, 36%) (46). In Tanzania, among 60 surveyed youth (age 15 to 19), 92% agreed that health professionals should use Facebook to provide sexual health information, although there were some concerns about mixing the primarily social purpose of Facebook with this information (47). Similarly, 66% of 1107 youth age 16 to 24 in Cape Town expressed interest in online HIV prevention programming (12). Interest was higher for school-based programs (85%) and lower for SMS-based programs (55%) (12).

Technology interventions for HIV among youth

HIV technology interventions for youth outside of the US

We identified four recent studies conducted outside of the US that describe the development or evaluation of technology-based HIV interventions for youth (Table 1). Rana et al. describe results from six focus groups conducted in Uganda with 39 youth (age 14 to 24) living with HIV to assess their opinion of the Reminding Adolescents to Adhere (RATA) SMS intervention. Ninety-seven percent thought RATA would help them with adherence (particularly the reminders and social support features); however, some concerns were expressed over accidental disclosure of HIV status and restrictions on using mobile phones at school and at home (48).

Two studies (49, 50), both theoretically based on the Information, Motivation, Behavioral Skills model (51), used web-based formats to deliver HIV/STI prevention to youth. The Internet-based HIV/STI prevention intervention (I-STIPI) consisting of four online modules was evaluated for preliminary efficacy among 40 sexually active Chilean women (age 18 to

24) in a pre-posttest design. At four weeks, significant improvements were found in HIV/STI knowledge ($p < 0.001$), condom use attitudes ($p = 0.019$), and self-efficacy for HIV/STI prevention ($p = 0.044$) (49, 52). Cybersenga, a school-based intervention consisting of five one-hour modules, delivered in four tracks based on gender and sexual activity (abstinent versus sexually active) was evaluated against a treatment-as-usual control group among 366 students aged 13 to 18 in Uganda. Half of the intervention participants were further randomized to a booster session. At six months, investigators found significant improvements in both intervention groups compared to control in HIV prevention knowledge and condom use intentions, attitudes, and subjective norms. Greater improvements were found among the group receiving the booster (50, 53).

Investigators in Colombia evaluated DoctorChat Mobile, a mobile app that allows participants to ask doctors about sexual and reproductive health and receive personalized feedback. The study was conducted among university students, ages 18 to 29, with access to mobile phones. Of the 257 volunteers, 58 (22.6%) used the app, with only 34 (13.2%) using it more than once. There were no significant changes in sexual and reproductive health observed (54).

US-based HIV technology interventions for youth

Results of US-based HIV technology intervention studies ($n = 24$ citations) for youth include those using SMS-texting, websites (including mobile optimized websites), and interventions delivered or evaluated using social media (Table 1). Below, we highlight eight of these studies demonstrating a novel approach to technology interventions among youth in regard to content, delivery, target population or public health impact.

SMS-texting—SMS texting is efficacious for encouraging HIV prevention, testing, care, and medication adherence (55, 56). A recent study by Sheoran et al. used texting to evaluate The Hookup, a weekly SMS intervention for adolescents age 13 to 24 in California that provides sexual and reproductive health information and linkage to local resources (57). All subscribers of The Hookup ($N = 2477$) received a request to complete a four-question survey by SMS. A total of 832 (33.6%) subscribers responded to the initial question and 482 (19.5%) answered all four questions. Those that responded did so quickly (e.g. of the responses, 98% were received in the first 24 hours of the initial request) providing some evidence for feasibility of using SMS to gather response data from youth in a rapid, cost-effective manner. The low completion rate (19.5%) highlights the need to consider additional mechanisms to increase engagement (58).

Web/mobile-optimized web—The majority of interventions identified utilized computers and/or websites—including those optimized for mobile phones. We highlight the unique aspects of five interventions below.

It's Your Game (IYG)-Tech is a stand-alone, 13-lesson Internet-based sexual health life-skills curriculum for middle school youth (59). IYG-Tech was adapted from It's Your Game... Keep it Real, a middle school sexual health curriculum shown to delay sexual behavior (60, 61). IYG-Tech was evaluated as an intervention to delay sexual initiation using a randomized, two-arm nested design among 19 urban schools in Texas. The target

population was English-speaking eighth-grade students (n=1374) followed into ninth grade. Findings indicated that IYG-Tech impacted some determinants of sexual behavior (e.g. STI and condom knowledge, attitudes about abstinence, condom use self-efficacy) but did not impact sexual behaviors or sexual initiation (62). Unique aspects: school-based sample of middle school youth (mean age 14.3), predominantly minority (74% Hispanic (English speaking) and 17% African American).

Queer Sex Ed is an online, multimedia sexual health intervention consisting of five modules designed to promote comprehensive sexual health for lesbian, gay, bisexual and transgender (LGBT) youth, age 16-20. The intervention is user-driven and was evaluated in a pre-post design with 202 youth. Follow-up at two weeks post intervention completion revealed extremely positive attitudes toward the intervention. Intervention effect sizes were small for sexual orientation (e.g., internalized homophobia) and relationship variables (e.g., communication skills) but moderate for safer sex (e.g., contraceptive knowledge) outcomes (63). Unique aspects: younger LGBT youth sample (mean age 17.9 years) and content focused on comprehensive sexual health promotion for LGBT youth.

Outlaw et al. demonstrated initial feasibility of an individually tailored computer-based two-session interactive motivational interviewing (MI) intervention for youth newly recommended to start antiretroviral therapy (ART). Intervention sessions lasted about one hour and took place one month apart. Ten participants, ages 16 to 24, participated. The intervention consists of “conversations” with one of seven animated, two-dimensional characters. Tailoring is based on participants’ goal setting and ratings of the importance of and confidence for HIV medication adherence (64). Unique aspects: use of animated character software to deliver an online MI intervention and focus on HIV+ youth starting ART.

Get Connected! is a tailored web-based intervention designed to increase HIV/STI testing among YMSM (ages 15-24) in Southeast Michigan. Get Connected uses YMSM’s psychosocial data (i.e., age, race/ethnicity, sexual identity, relationship status, HIV/STI testing history and testing motivations, recent sexual behavior, sources of support, structural barriers, and values) to personalize imagery and content that each youth receives within the four web pages that make up the intervention. In a pilot randomized controlled trial (RCT) (n=130) compared with a control condition consisting of a sortable web directory of HIV/STI testing providers (including contact and location information), those in the intervention arm perceived a higher credibility of the online content. Of the 104 participants who answered the 30-day follow-up assessment, 30 reported having tested for HIV/STIs, with the majority of these participants (n=22) in the intervention condition compared with the control condition (n=8) (65). Unique aspects: use of community based participatory research to guide intervention development and use of multilevel comprehensive tailoring algorithm to motivate HIV/STI testing among YMSM.

HealthMpowerment (HMP) is a mobile phone-optimized, Internet-delivered intervention developed through a multistage process based on iterative feedback from focus groups, individual interviews, and usability testing with the target population of Black YMSM and transgender women (TW) (age 18 to 30) (19, 66). The intervention provides information,

resources, tailored feedback, game-based elements and a social networking platform to offer and receive social support. In a one-month pilot trial utilizing a pre-post design (n=15), statistically significant improvements were seen in social support (p = .012), social isolation (p = .050), and depressive symptoms (p = .045) (67). An RCT is underway to test HMP against a control website consisting of HIV/STI information (67). Unique aspects: intervention focuses on Black YMSM/TW and includes social interactions and game based elements.

Social media—Interventions delivered via social media can quickly reach large audiences through familiar platforms building on the trust and influence of social networks. A recent review on the use of social media to achieve positive health outcomes among adolescents and young adults concluded that while social media can be an effective way to reach this age group, most studies to date were preliminary, limited in methodologies, and mostly centered on evaluating how youth use social media and the resulting health implications (68).

The IknowUshould2 was a campaign targeting youth age 13 to 24 (with a primary focus on those under 18 years of age) launched in Philadelphia to increase HIV/STI knowledge and testing. The campaign was primarily social-media based (website, Facebook, Twitter, Instagram, YouTube) but also included traditional media and in-person events. During the first six months, the campaign's Facebook page received approximately 6,000 visits and 1,500 unique individuals used the campaign's webpage. At associated clinics, comparisons of pre- and post-campaign launch records reveals significant increases in HIV and syphilis testing rates among all youth and increases in the proportion of visits where 13 to 17 year olds were tested for any STI (69).

MiCHAT is a live chat intervention for 18 to 29 year olds delivered on Facebook consisting of eight one-hour motivational interviewing and cognitive behavioral skills-based online sessions designed to reduce condomless anal sex and substance use among high risk YMSM. In a pre-posttest design among 41 participants with no control group, investigators found that participation in at least one session of the intervention (n= 31) was associated with reductions in days of drug use (5.52 vs. 3.30, p=0.073) and heavy alcohol use (10.7 vs. 8.52, p=0.082) in the past 30 days and instances of condomless anal sex (8.96 vs. 3.11, p=0.042), and condomless anal sex under the influence of substances (6.89 vs. 0.81, p<0.001) (70).

Discussion: Emergent issues in the field

The proliferation of social media platforms has transformed Internet utilization and the ability to reach and interact with youth. In contrast to static websites where consumers were limited to passive viewing, new technologies allow co-creation of user-generated content within intervention forums and public virtual communities (10). As the field of technology and HIV continues to grow, we will need to be mindful of the rapidly changing technologies being used by adolescents and young adults. Our review suggests that technology-based studies with “youth” encompass a large developmental age range (13 to 30 years), with the majority focusing on young adulthood. The varying developmental demands within this age group will require different research/intervention considerations based on developmental

tasks and milestones (13, 71). Future research is warranted on developmentally appropriate tailoring, alongside comparisons of differing developmental periods. In addition, attention to ethical issues relevant to the development and implementation of technology-based interventions for youth such as obtaining online consent is critical (13, 24).

Review findings caution against inferring temporal associations from observational studies of technology use and HIV risk among youth. Parallel to early research with computer-mediated technology (e.g. see review by Grov et al. [72]), care should be taken not to confound youth's pervasive use of technology with their risk-taking behaviors; rather, we must carefully pinpoint the contexts in which technology use increases youth's vulnerability to HIV risks. For example, although much of the literature suggests that sexting is associated with sexual risk-taking, the causal mechanisms linking sexting and risk behaviors are unclear (28). It is possible that youth who are more likely to engage in risk behaviors offline are also engaging in sexting as foreplay with partners with whom they are already sexually involved. Longitudinal studies are needed to test these hypotheses. Furthermore, the relation between sexting and sexual behavior may be connected to new relationship dynamics among youth who have grown up sharing their lives through online technologies (73). In light of these trends, we must purposefully report the theoretical mechanisms that are being studied when we test the association between sexting and HIV risk, and contextualize our findings based on the study population's age (adolescents versus young adults). Within existing HIV/STI interventions for youth, components may be needed that specifically address negative sexting-related consequences.

In recent years a burgeoning number of technology-based interventions for HIV prevention and care have been published, with even more under development (14). As shown in prior reviews (14, 74), the majority of published studies continue to be reported from the US. The disproportionate burden of HIV morbidity and mortality globally among adolescents (6) combined with the exponential growth of mobile phone ownership and Internet access in many developing countries (8, 9) underscores the urgency for more broadly expanding eHealth and mHealth interventions to youth worldwide.

While many of the studies identified employed behavior change theories to inform their intervention content, researchers have provided limited information on what theories (e.g., computer-mediated communication theories, health informatics, health literacy) inform the design of the technological aspects of their interventions. Cheek and colleagues (75), for example, integrated Self-Determination Theory with Gaming Theory to design an online depression treatment intervention for adolescents in Australia. Inclusion of these details may help researchers identify which technological components have greater success than others when working with youth across different settings (76). Future research could examine how design and infrastructure components of technology-driven interventions contribute to study outcomes. In addition, incorporating in-person or "virtual" (e.g. home HIV testing) biologic outcomes will allow for more robust evaluations.

Conclusion

While the speed of technology and availability of commercial resources often far outpaces what can be achieved in the public health research domain, many exciting opportunities remain. Although the majority of currently published studies have utilized website or SMS-based modalities, a growing number of researchers are exploring technologies that are particularly relevant for youth, including smartphone apps, social and sexual networking services, virtual reality, and gaming elements (e.g., gaming, rewards, competition). These technologies offer key functions that are particularly relevant within a youth HIV context, including anonymity, social support, provision of real-time assessment and feedback, and highly engaging features (14, 77).

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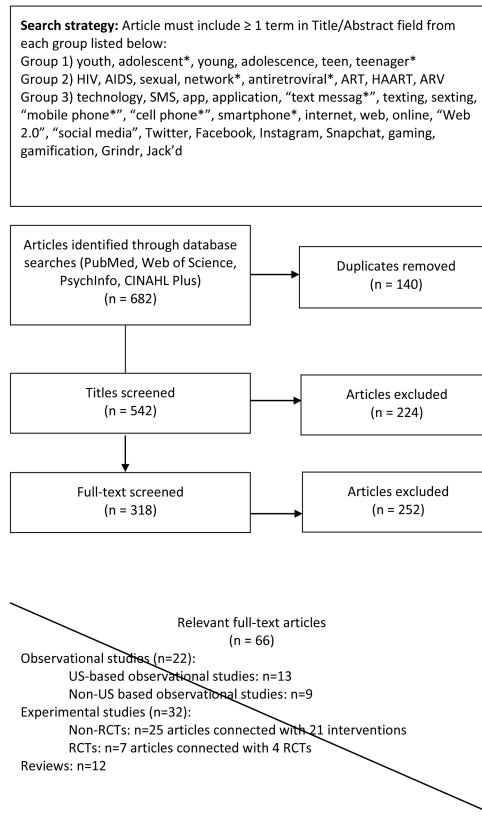


Figure 1. Search strategy and disposition of citations. To be included, articles had to contain one or more of certain terms in the title or abstract. Then, articles were screened based on the criteria described in the figure.

Table 1

eHealth HIV-interventions for youth

Author (Year) Location	Technology	Population (Sample Size)	Study design Length of intervention	Behavioral theory	Results
<i>Studies conducted outside of the U.S.</i>					
Rana et al. (2015) Kampala, Uganda	Mobile phone - SMS	YLHIV, age 14- 24 (n=39)	4 focus groups to assess acceptability of Reminding Adolescents to Adhere (RATA), SMS for adherence and social support	Information, Motivation, Behavioral Skills model	90% could write, read, and send texts; 72% own a cell phone (41% share a phone), 97% thought RATA would help with adherence. Some concern over accidental disclosure of HIV status and sustainability of the program due to acclimation or boredom with messages.
Lopez et al. (2014) Colombia	Mobile phone - app	Youth, age 18- 29 (n=58)	I: Users send sexual health questions and receive personalized physician responses C: none 6 months, FU month 6	NR	High loss to follow-up: 54.7% (127/232) completed FU; Low app use: 54.3% (69/127) did not use app; 41% of remaining sample (24/58) used app only once. No significant changes in sexual and reproductive health. Among retained app users (n=58): 92% valued access to a mobile-based teleconsultation tool on sexual health, 69.7% said app was easy to use.
Villegas et al. (2014) * Villegas et al. (2015) Chile	Web	Chilean women, age 18-24 (n=40)	I: STI/HIV prevention intervention (I-STIPI) (adapted Mano a Mano-Mujer and SEPA) 4 weekly 40-50 min. modules (STI/HIV information, partner communication, domestic violence, substance abuse) C: none 4 weeks, FU week 4	Information- Motivation- Behavioral Skills model	Significant improvement: STI/HIV knowledge (p < .001), condom use attitudes (p = .019), STI/HIV prevention self-efficacy (p = 0.044); Moderate difference: Sexual Risk Taking with Uncommitted Partners Subscale (p = 0.10). NS: Traditional Gender Roles, Perceived Support for Violence Scale, Norms About the Use of Condoms Scale, Risky Sex Acts Subscale, Partner Communication.
Ybarra et al. (2014) * Ybarra et al. (2015) Mbarara, Uganda	Web	Students, age 13 - 18 (n=366)	I: CyberSenga, school-based, 5 × 60 min. modules (HIV information, decision making, communication, motivation to be healthy, condom use, healthy relationships) 4 tracks by gender and abstinent vs sexually active I+: I plus booster module C: SOC 5 weeks, FU months 3 and 6	Information- Motivation- Behavioral Skills model	Significant changes I+ vs I vs C: Higher HIV prevention knowledge scores (82.8% vs 77.6% vs 72.4%), greater improvements in condom use attitudes (4.4 vs 4.1 vs 3.8), condom use subjective norms (4.2 vs 4.0 vs 3.8), and intentions to use condoms (4.2 vs 4.0 vs 3.7). NS: change in HIV prevention-related attitudes, behavioral skills for condom use, motivation and behavioral skills for abstinence

Studies conducted in the U.S. – Formative/evaluative studies

Enah et al. (2014) Alabama, USA	Web	Rural youth, age 12-16 (n=38)	4 focus groups to gather formative data for the design of an HIV prevention game.	Model of Adolescent Sexual Risk Behaviors	Four recommendation areas: 1) player control (design avatars, physical attributes of the player's girlfriend/boyfriend, and activities in which the player normally participates), 2) virtual monetary reward systems, 3) immersive action in real world scenarios or missions, 4) tailor to individual differences.
Enah et al. (2015) Alabama, USA	Web	Rural African American youth, age 12- 16	4 focus groups (by age and gender) to assess acceptability and relevance of "Fast Car", free web-based HIV-prevention	NR	Participants found game educational and moderately entertaining. Recommendations: make game more engaging, design game to be more visually appealing, player controlled, reflective of adolescents' daily lives, and individually tailored.

Author (Year) Location	Technology	Population (Sample Size)	Study design Length of intervention	Behavioral theory	Results
Guiliana-Ramos (2015) 6 USA cities	Web	(n=42) Youth, 97% age 12-19; 53% Black/ African American, 34% Latino (n=106 youth)	game developed by UNESCO. 14 focus groups (6 with parents, 8 with adolescents) on feasibility and acceptability of online and mobile technology- based parent-adolescent sexual health interventions.	NA	Majority of parents and adolescents use digital devices (youth: SMS, social networking, music, videos, games; parents: phones (calls), computers (email and information gathering). Internet was a source of sexual health information but concerns about overwhelming amount of material and finding accurate information. Emphasis on tailoring intervention content. Youth reported barriers: discomfort discussing sexual health with parents, cultural and generational differences. Emphasis on positive relationships with parents as a facilitator.
Mustanski et al. (2014) USA	Web/SMS	Young gay and bisexual men, age 14-18 (n=75)	4 online focus groups stratified by anal or vaginal sex ever vs. never, on condom use decisions. Assessed differences by age, sexual experience, and rural/urban residency to inform Guy2Guy, SMS-intervention.	Information- Motivation- Behavioral Skills Model	Three themes: 1) relationship factors (duration, marriage/monogamy, trust), 2) issues related to accessing/buying condoms, 3) attitudes and experiences with/about condoms (discourage use: knowing partner is "clean", decreased sensation, seen as unnecessary, awkward, fear parents might find them; encourage use: view condoms as effective, fear consequences like STIs). Sexually experienced participants talked more about condoms (n=223 excerpts, 66.6% vs. n=112 excerpts, 33.4%). Younger participants more likely to raise issues related to accessing condoms, e.g. cost.
Sheoran et al. (2014) California, USA	Mobile phone - SMS	Youth in California, age 13 – 24 (n=2477)	Evaluation of The Hookup, weekly sexual health SMS service 4 question SMS survey	NR	Received 481/2477 (19.4%) completed surveys. 90% of users reported behavior change since starting to receive texts (e.g. condoms (33%), increased knowledge/awareness (24%), initiated birth control (15%), got tested for HIV/STDs (15%)).
Gaynsnsky et al. (2014) USA	Social Media	YLHIV, age 16- 27 (n=43)	Evaluation of a private Facebook group established for members of an HIV clinic's young adult program. 16 month study period	NR	3838 posts and comments. Content analysis: 42% of content classified as "administrative/engagement in group" functioned to enhance operations of the program. Positive interactions were common: socializing (25%), banter (20%), offers of social support (15%). Most common types of support noted: emotional support (requested), "esteem support" (provided).
<i>Studies conducted in the U.S. – Feasibility, pilot, observational studies, randomized trials</i>					
Thurston et al. (2014) USA	Mobile phone - SMS	YLHIV (including YLGB), age 13- 24 (n=30)	I: Positive STEPS, 5 × 60 min. I- on-1 in-person sessions with clinician to address 11 adolescent adherence barriers, custom reminder texts. C: NR 12 weeks, FU week 14	Based on Life- Steps (EBI of cognitive- behavioral therapy, motivational interviewing, and problem solving)	Qualitative descriptions of two case studies (perinatally infected heterosexual woman, behaviorally infected gay man) show how the intervention can be individually tailored for patient needs. Future studies may assess changing the number of sessions and adding booster sessions.
Danielson et al. (2014) USA	Web	African American female youth, age 13-18 (n=18)	I: SiHLEWeb (adapted from SiHLE EBI). 4 × 60 min. video modules. C: NA, Usability testing	Social Cognitive Theory; Theory of Gender and Power	Most users enjoyed and learned from the videos, found content relevant. Critiques: some videos too long and included some unexpected tone/content (e.g. statements made by an intentionally provocative character).
Hightow-Weidman et al.	Web (mobile- phone	YBMSM/TW, age 18-30	I: "HealthMPowerment" (HIV/STI information, risk	IOM's Integrated	Website visited 544 times, average time spent 9:21 min. 10,800 page views, average 20 page views per visit.

Author (Year) Location	Technology	Population (Sample Size)	Study design Length of intervention	Behavioral theory	Results
(2015) North Carolina, USA	optimized)	(n=15)	assessments, social support, resources, Q&A, rewards) C: NA, Pilot study 4 weeks, FU week 4	model of behavior theory	Results suggest intervention may have increased social support and improved mental health however no outcome variables were statistically significant. Intervention highly acceptable (p<0.01).
Mustanski et al. (2015) USA	Web	YLGBT, age 16- 20 (n=202)	I: Queer Sex Ed, 5 modules guided by female-bodied avatar ("Ed") with quizzes. C: NA, pre-posttest design User-driven length, FU at 2 weeks post-I.	Information- Motivation- Behavioral Skills Model	Average time spent on intervention: 107.8 minutes (SD=53.1) Moderate impact on sexual orientation items (e.g. internalized homophobia d=0.06) and safer sex items (e.g. HIV knowledge d=0.21), impact on HIV knowledge greater increase in number of items answered correctly for females vs males (10.0% vs 5.4%, p<0.05). Time spent on intervention (p<0.001) and content rating (p<0.05) associated with outcome scores.
Outlaw et al. (2014) USA	Web	YLHIV, age 18- 24 70% African American, 30% Latino, 60% gay/lesbian (n=10)	I: User interacts with animated characters, tailored intervention messages based on user's responses, goals set and goal progress C: NA, pilot study 2 x 1-hour sessions	NR	All participants' ratings were high for importance of HIV medication adherence. 80% rated high confidence for adherence. 90% chose goal of taking HIV medication as prescribed; 90% reported success in reaching that goal. Satisfaction with program: between 80-90% for both sessions.
Dowshen et al. (2015) USA	Social Media	Youth, age 13 - 24 (n=104 surveys; all pre-post clinic records)	I: "IknowUshould2" social media campaign on STI/HIV test attitudes, beliefs, norms C: NA, quasi-experimental Campaign: 7/2012 - 8/2013	Integrative Model of Behavior	First 6 months of campaign: 6000+ visits to Facebook page from 1500 unique individuals. Low STI knowledge among 104 survey respondents, 46% never tested for HIV or STIs. Visits to referral STI clinic increased from 4386 pre-campaign to 4628 during the campaign. Increase in number of total tests and proportion of visits at which Syphilis (5.4 vs. 18.8 %; p=0.01) and HIV (5.4 vs.19.0 %; p=0.01) testing were conducted.
Leluti- Weinberger et al. (2014) USA	Social Media	YMSM, age 18- 29 (n=41)	I: "MiCHAT" 8 weekly 1-hour MI and CBT skills-based chat sessions via Facebook. C: none, feasibility study 8 weeks, FU weeks 8 and 12	Information- Motivation- Behavioral Skills Model	Pre-post reductions in past 30 days: days of drug (5.52 vs. 3.30, p=0.073) and heavy alcohol use (10.7 vs. 8.52, p=0.082), and episodes of UAI (8.96 vs. 3.11, p=0.042), and UAI+substance use (6.89 vs. 0.81, p<0.001). Significant increases in HIV risk knowledge.
Bauermeister et al. (2015) Southeast Michigan, USA	Web	YMSM, age 15- 24 (n=130) I=86, C=44)	I: Get Connected!, information for HIV testing sites, tailored for YMSM, user filtering by need (e.g. insurance concerns, proof of income/ID, transportation) C: Sortable, ranked online provider directory 30 days, FU post-I	Self- determination theory; Integrated Behavioral Model	I vs C: information perceived as more accurate (1-7 scale, 1 = strongly disagree, 7 = strongly agree; 6.35 vs 5.74, p<0.01), 90% of those who got tested during the 30 day follow-up period reported Get Connected! useful for identifying an HIV/STI clinic. Greater increases in self-efficacy to persuade partner to get tested (p < .01) NS trends: I vs C: Higher reported rate of making HIV/STI test appointments (32.4% vs 27.8%) and getting HIV/STI tests (32.4% vs. 22.2%). Decrease in number of sex partners past 30 days across entire sample (1.84 vs 1.39).
Belzer et al. (2015) * Belzer et al. (2014) USA	Mobile phone	YLHIV, age 15- 24 (n=37)	I: Daily contact from adherence facilitator (ART reminder, problem solving) C: SOC 24 weeks, FU post-I	Social support theory	I vs C: higher self-reported adherence past: 3-months (OR = 2.85, 95% CI 1.02-7.97), month (3.09, 1.20-7.98), 7-days (3.76, 1.15- 12.25), last week-end (3.62, 1.26-10.41). Significant decrease in mean log 10 HIV VL at 24 weeks (2.82 vs 4.52) and 48 weeks (3.23 vs 4.23).
Shegog et al. (2014) * Peskin et al.	Web	8 th graders, mean age 14.3; 74% Hispanic,	I: It's Your Game (YG-Tech), 13 x 35-45 min. lessons. Animated narrators introduce activities (e.g. skills practice, peer	Social Cognitive Theory & Theory of Triadic	Only 14% received full intervention. I vs. C: greater knowledge of STIs (β (difference in adjusted means)=0.05, p<0.05) and condoms (β=0.07, p<0.01), more positive beliefs about waiting until marriage to have sex (β=0.08, p<0.05), perceive friends have knowledge.

Author (Year) Location	Technology	Population (Sample Size)	Study design Length of intervention	Behavioral theory	Results
(2015) Southeast Texas, USA		17% African American, 9% other (n=1374, 19 schools randomized)	modeling videos, role-play, quizzes C: State-approved health education (textbook-based) 1 academic year, FU 1 year	Influence	more positive beliefs about abstinence ($\beta=0.09$, $p<0.05$), greater self-efficacy to use condoms ($\beta=0.09$, $p<0.01$), more likely to think other teens who had sex wish they waited ($\beta=0.09$, $p<0.05$) and that most teens their age not having sex ($\beta=-0.08$, $p<0.05$). NS: delay of sexual activity or any sexual behavior.

I = Intervention group condition; C = Control group condition; EBI = evidence based intervention; FU = follow-up; VL = viral load; SOC = standard of care; YLHIV = youth living with HIV; YMSM = young men who have sex with men; YBMSM = young black men who have sex with men; TW = transgender women; YLGBT = young lesbian, gay, bisexual, transgender persons; HIV = human immunodeficiency virus; STI = sexually transmitted infections; UAI = Condomless anal intercourse; NA = not applicable; NR = not reported; NS = not significant; SMS = short message service/text message; IOM = Institute of Medicine; VL = viral load

* Feasibility/acceptability study or sub-analysis, results not presented.