Original Article

A Systematic Review and Meta-analysis of Interventions for Sexual Health Promotion Involving Serious Digital Games

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Abstract

Objective: Serious games may be effective in promoting sexual health behavior. Their confidential nature may encourage users to discuss sensitive sexuality topics. Furthermore, they can tailor messages to the individual's needs and may be intrinsically motivating. This meta-analysis investigates the effectiveness of interventions for sexual health promotion that use serious games.
Materials and Methods: A database search was conducted in PubMed, Web of Science, CINAHL, and PsycINFO for publications before the end of July 2013. Serious digital games studies measuring effects on behavior or its determinants, using a control condition, allowing the calculation of an effect size (Hedges' g, random-effects model) were included.
Results: Seven game studies for sexual health promotion were included. These showed positive effects on determinants ($g = 0.242$; 95 percent confidence interval, 0.129, 0.356), albeit of small effect size. The effects on behavior, measured in only two studies, were not significant ($g = 0.456$; 95 percent confidence interval, -0.649, 1.561). Most games did not use many game features that are considered to be immersive or enhancing flow. Instead, there was a strong reliance on pure gamification features, such as rewards and feedback.
Conclusions: The effectiveness of the next generation of games may be enhanced by building on the behavioral change and educational gaming literatures (e.g., using role-play and simulation game formats, individual tailoring, offering adaptation in the difficulty of the challenge, and amount and timing of the feedback). There is a need for studies with rigorous evaluations of game effectiveness, longer-term follow-up, and using measures of behavior rather than merely their determinants.

Introduction

SEXUAL HEALTH EDUCATION has experienced an upswing in the application of technology. Such interventions hold promise of more easily reaching at-risk populations, maximizing fidelity of program content, and overcoming traditional organizational and individual barriers to program implementation, including facilitator training and materials cost.[1,2] Several computer-based interventions have demonstrated significant, albeit small, positive effects on sexual health behavior.[2–4] Effect sizes for increased condom use are similar to those obtained with face-to-face interventions[2] and even larger for increased sexual health knowledge in comparison with face-to-face interventions.[3] Effects of computer-based interventions were also higher when they targeted non–mixed gender groups, used individual tailoring, applied the Stages of Change Model, or included more sessions.[2]

Serious digital games have also been applied to improve sexual health. Serious digital games are a form of play using interactive computer-based game software, which aim (1) to train or educate people and (2) to be highly enjoyable, attention-captivating, and intrinsically motivating. Serious games have gained momentum as a health promotion tool in various health domains.[5,6] Systematic reviews have demonstrated effects of serious digital games in improving health behavior.[7–13] Serious games may offer several advantages as a mode of delivery to promote sexual health behavior: (1) They may provide anonymity and confidentiality,[14] which are important for users to disclose sensitive information on sexual

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behavior[15]; (2) they allow tailoring to preferences and needs of players,[7,16] including tailoring on gender-based preferences, ethnic background, sexual orientation, sexual experience, or sexual intentions[17–23]; and (3) they may increase attention and learning because of the immersion in the game state and the experience of ''flow,'' where intense concentration from players minimizes distractions, disbelief, and sense of time.[24,25]

This study has two objectives. First, we summarized published evidence on serious games for sexual health behaviors and examined whether immersive and health-promoting game features were incorporated. Second, we investigated the overall effectiveness of serious digital games to promote sexual health behavior using meta-analysis. A meta-analysis overcomes the problem of small sample sizes in individual studies, which often make it hard to conclude the effectiveness of a particular intervention.[26] As such, results of this study may provide guidance to researchers and serious game developers on developing the next generation of evidence-based serious games for sexual health promotion.

Materials and Methods

Cochrane guidelines were used in the design of the research protocol.[27] Meta-analysis reporting was guided by the PRISMA statement.[28]

This article is part of a larger project on the effectiveness of serious digital games on healthy lifestyles.[29] The present article focused on the subset of games that aimed to improve sexual health behavior (e.g., preventing teenage pregnancy, delayed initiation of sex, refusal skills for sexual coercion) or to reduce sexual risk behavior and related diseases (e.g., human immunodeficiency [HIV]/AIDS and other sexually transmitted infections). Sexual health was defined as ''a state of physical, mental and social well-being in relation to sexuality. It requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination and violence.''[30]

Search strategy

Table 1 specifies inclusion and exclusion criteria for game studies in the review.

PubMed (initiated in 1966), Web of Science (initiated in 1926), CINAHL (initiated in 1937), and PsycINFO (initiated in 1887) databases were searched for English-language publications since the start of the journal databases until the end of July 2013, with the key words (''games'' or ''video games'' or ''interactive multimedia'') and health. Search results were complemented with hand-searching studies reported in the above-mentioned reviews, examining the table of contents of relevant specialized journals and databases (*Computers in Human Behavior*; *Games for Health Journal*; *CyberPsychology, Behavior, and Social Networking*; *Telemedicine and E-Health*; and the Health Games Research database) and by requesting qualifying manuscripts to the local Digital Games Research Association chapter. Authors were contacted for more information when data for coding or effect size calculation were missing.

Coding frame

Primary and secondary outcomes. The primary outcomes were categorized under the following codes: Behavior, knowledge, behavioral intention, perceived environmental constraints,

TABLE 1. INCLUSION AND EXCLUSION CRITERIA

Inclusion	Definition	Exclusion
Games	Organized play having a set of rules by which to play and a goal, which creates a challenge, provides feedback or shows outcomes, entails interaction, and has a topic	Multimedia programs that are not games (e.g., watching video without any interaction)
Serious games	Made specifically to promote health while also being fun	Commercially available, games only developed for entertainment or leisure purposes (e.g., commercial exergames such as the Wii)
Digital game	Includes all games using computer technologies as a device	Games not played on digital media (e.g., board games)
For healthy lifestyle promotion	The study's primary outcome should focus on healthy lifestyle behavior or one of its determinants.	Games that only target increased skill level, but no lifestyle change (e.g., athletic performance), that are only used in a therapeutic context and with no intent to create a lifestyle change (e.g., treatment support), or that are used for professional education
Effect studies	Games evaluated for their effects and that allowed an effect size to be calculated for behavior or its determinants	Studies that only reported usability evaluations, player experiences, or case studies or that only reported effects on clinical outcomes but no healthy lifestyles
Research designs	The following research designs were included: (1) pretest–posttest with control group (randomized on individual level); (2) pretest–posttest with nonequivalent control group (randomized at group level); (3) posttest only control group design; and (4) nonequivalent posttest only control group design.	The following designs are excluded: (1) one group pretest–posttest; and (2) one group posttest only design.

skills, attitudes, subjective norm, and self-efficacy.[31] The secondary outcome concerned clinical effects (e.g., rates of sexually transmitted infections).

Game design. The coding of game characteristics was based on information from several reviews that linked game features to educational outcomes.[7,32,33] These characteristics have been reported in previous studies or theories as facilitative of behavior change, but these features were not tested in our meta-analysis for their influence on behavior change. All features were recoded into dichotomous categories (used, not used). Features coded were as follows:

1. individual tailoring or adaptation[34,35]
2. personalization of the character to resemble the player[24]
3. personal goal-setting, where players set a plan of how they will reach a goal[36]
4. narrative or story[24,25]
5. scaffolding levels, where challenges need to be mastered before continuing on to the next level[37]
6. challenge of increasing difficulty[38,39]
7. interactivity (i.e., the amount of active control over the content or gameplay the player has[24])
8. rewards, consisting of various types of scoring or reinforcement systems[31]
9. immediate feedback (i.e., information on how players mastered the challenge and providing support in progressing to the goal[24,38])
10. assignments for real-life transfer that players perform outside of the game but that are closely linked to the game.[40,41]

Reliability of coding. Two coders (A.D.S. and Maddalena Rodelli) independently scored all sexual health games on the coding dimensions. Initial inter-rater reliability indicated high agreement ($\kappa = 0.84$).[42] All differences were discussed until full agreement was reached.

Meta-analysis procedure

For the meta-analysis, the effect size index used was Hedges' g, which corrects for small sample sizes.[43] A negative or a positive Hedges' g reflected, respectively, a reduction or increase in sexual health behavior or its determinant after playing the game. For all analyses, we chose a random-effects model. No moderator analyses were performed because of the limited number of studies. Cochran's Q test and I^2 statistics[44] were reported to investigate the degree of heterogeneity in effect sizes. To maintain independence of data, whenever necessary, effect sizes were averaged across different outcomes. All analyses were performed with Comprehensive Meta-Analysis software, version 2.2.050 (Biostat Inc., Englewood, NJ). Effect sizes of ≥ 0.80 were considered large, ≥ 0.50 were considered moderate, and ≥ 0.20 were small effects.[45]

Results

The database search yielded 7192 hits. After removing duplicates (1473), nonqualifying articles based on abstract and title (5719), and nonqualifying articles after reading full text (318), 51 game studies were retained. Sixteen studies were added from other sources, resulting in a total of 67 studies. Thirteen studies were additionally removed because they did not include a control condition, resulting in 54 included game studies for health promotion, of which 7 studies evaluated sexual health games (Fig. 1). Each game was evaluated in only one study. A detailed description of the studies is provided in Table 2.

"Prepare"[46,47] (United Kingdom) is a game targeting adolescents (13–14 years of age); it used dating scenarios and was intended to be played under teacher guidance in class. The "Web-based HIV module"[48] (United States) targets adolescents (12–18 years of age) and consists of interactive quizzes to complement a standard face-to-face intervention. "The Baby Game"[49,50] and "The Romance Game"[49,50] (United States) target adolescents (13–18 years of age) and was described as an action game. "Midlife Women Online"[51] (United States) was aimed at women 40–55 years of age and used a quiz, presented after participants watched a video. The "It's Your Game" intervention[52,53] (United States) targeted 7th–8th graders; several game formats were used, in addition to course material and parent–child activities. "SAHARA"[1,54] was a computer-based version of an earlier intervention, "SISTAS" (United States). It had game modules or components but was not truly intended as a computer game. The intervention was designed for African American women 19–29 years of age.

Sample

Nearly all included studies evaluated games in the United States ($n = 6$). Five studies investigated games targeting adolescents, whereas two investigated games targeting adults (only women). All included studies used games designed for at-risk groups, based on the users' ethnicity (e.g., African American), age-related issues (e.g., teenage pregnancy), or psychosocial risk factors (e.g., substance abuse). On average, 65 percent of participants were female, and the mean age was 20.42 years (standard deviation = 11.96 years; average age range, 13–42 years).

Game objectives

Four of the five game studies for adolescents (12–18 years of age) targeted a decrease in adolescent pregnancy. Most of these game studies attempted to delay sexual initiation among teenagers,[49,53] whereas one game study sought to increase relationship skills and improve resistance against sexual coercion.[46] Three of the five game studies for adolescents also intended to decrease sexually transmitted and HIV infections,[46,48,53] by delayed sexual initiation, resistance against sexual coercion, or promoting sexual risk-reduction behavior (e.g., condom use). Of the two studies evaluating games for adult women (>18 years of age), one was intended to prevent unintended pregnancy by a better awareness of medical information, contraceptive choices, and communication methods.[51] The other was intended to prevent contracting HIV by increased condom-protected sex.[54] Both games also aimed to prevent contracting sexually transmitted infections.[51,54]

Outcomes

All studies measured the impact on knowledge ($n = 7$), and most also measured effects on attitudes ($n = 5$) or self-efficacy

TABLE 2. GAME DESCRIPTIONS

Game	Study population	Objective	Outcomes	Country	Multicomponent[a]
"Prepare"[46,47]	Adolescents 13–14 years of age, recruited from three schools; sample size: I = 298, C = 207	Teenage pregnancy prevention, resist sexual coercion	Knowledge/ attitude, self-efficacy	United Kingdom	Yes
Web-based HIV module[48]	Drug-using adolescents 12–18 years of age, recruited from one treatment facility; sample size: I = 28, C = 28	HIV and STI prevention	Knowledge, skills, behavioral intention	United States	Yes
"The Baby Game"[49,50] (cited as Paperny and Starn, 1989a in Table 3 and Fig. 2)	Adolescents 13–18 years of age, recruited from five schools; sample size: I = 177, C = 174	Delay parenthood among teenagers	Knowledge, attitudes	United States	No
"The Romance Game"[49,50] (cited as Paperny and Starn, 1989b in Table 3 and Fig. 2)	Adolescents 13–18 years of age, recruited from five schools; sample size: I = 192, C = 175	Improve knowledge on sexuality and contraception, increase interactive skills, improve responsible sexual decision-making	Knowledge, attitudes	United States	No

(Continued)

Description	Meta-analysis results	Follow-up
''Prepare'' (Positive Relationships: Eliminating Pressure and Sexual Coercion in Adolescent Relationships) was intended to be played as a group during class, under teacher guidance, and envisioned as an addition to existing Relationship and Sexual Education material, which generally showed only limited effects. Project design was guided by the Intervention Mapping Protocol. This was reflected in iteratively consulting the planning group and working from existing and newly collected evidence. Changing behavior and behavioral determinants was pursued by applying a combination of methods to address each outcome. For example, guided practice, enactive mastery experience, and verbal persuasion were used to increase self-efficacy. To increase knowledge, a combination of belief selection, anticipated regret, active learning, participation, advance organizers, discussion, and feedback, providing cues and modeling, was applied. The game consisted of two parts. A first part showed a teacher-led experience where players were asked to select scenario descriptions based on whether these constituted sexual coercion (''yes,'' ''maybe,'' ''no''). The second part showed consequences of actions and took the class through the scenario from the perspective of one of the characters. This second part has not yet been evaluated. A reward system on a group level was used, in which the class received a score reflecting the number of right answers.	Effects were small for knowledge and attitudes and very small for self-efficacy.	No
This intervention targeted a risk group for earlier initiation of sex and diverse other risk behaviors, such as having more sexual partners, prostitution, and low condom use. It was presented as an interactive, tailored, Web-based program, grounded in both prevention science and educational technologies of ''fluency-based computer-assisted instruction.'' The Web-based intervention part consisted of 25 modules and served as a complement to the standard intervention of a 1-hour session given by a trained educator. The 1-hour face-to-face session consisted of an informational lecture, skill demonstration, and a 15-minute video. The modules covered topics of STIs, HIV and AIDS, birth control, condom use, managing risk situations, and living with HIV or hepatitis C. A central component in the Web-based part was the interactive quizzes, which allowed assessment of how well the player mastered the content. This formed the basis for adjusting the pace and level of repetition to promote optimal retention. Content-tailoring was not only based on the player's proficiency level, but also built on his or her risk profile obtained at initial assessment.	Moderate effects were found for knowledge. The effects on behavioral intention and skills were small.	No
''The Baby Game'' was based on adolescent developmental theories, social learning theory, and decision theory. It aimed to increase adolescent knowledge about parenting and to encourage adolescents to re-assess their attitudes to teenage pregnancy. The game was described as an action game and included a question-and-answer format and simulations of the outcomes of player's choices in, for example, managing a teen family household budget or dealing with a child crying at night. It was intended to be combined with other initiatives in a multicomponent curriculum, such as group sessions and school programs, but was evaluated as a stand-alone game. A reward system was in place to reinforce right choices, whereas feedback and the opportunity to change strategies were provided with wrong answers. On average, 30 minutes was needed to play this game.	The effects on knowledge and attitudes were, respectively, moderate to large.	No
''Romance'' was developed by the same authors of ''The Baby Game.'' It was informed by the same theories. The game discussed birth control, abstinence from sexual intercourse, and personal sexuality. Although intended for both adolescents and young adults, it was only evaluated among adolescents. The storyline in this action game was of a boy or girl pressuring his or her partner to have sex, which, depending on the player's choices, resulted in sexual contact, handling a missed period, and contact with a Teen Sex hotline. The game ended with a fortuneteller who gave personalized suggestions. Contraceptive choices could be practiced during a Dating Game scenario, comprising 36 dates. As in ''The Baby Game,'' ''The Romance Game'' used rewards and feedback for right or wrong choices. As rewards, players were given a budget, which increased or decreased based on the choices made.	The game showed small effects for knowledge and attitudes.	No

(*continued*)

TABLE 2. (CONTINUED)

Game	Study population	Objective	Outcomes	Country	Multicomponent[a]
"Midlife Women Online"[51]	Adult women, 40–55 years of age, recruited from Craig's List postings and online recruitment sites; sample size: I = 81, C = 83	Prevention of unintended pregnancy and STIs	Knowledge, attitudes, self-efficacy, behavioral intention	United States	No
"It's Your Game"[52,53]	Adolescents, 7th–8th graders, recruited from 10 schools; sample size: I = 349, C = 558	Delayed sexual initiation, prevention of STIs, HIV, and teenage pregnancy	Knowledge, attitudes, subjective norm, self-efficacy, behavioral intention, behavior	United States	Yes
"Sahara"[1,54]	Adult African American women, 19–29 years of age, recruited from one Planned Parenthood service; sample size: I = 67, C = 68	HIV prevention	Knowledge, self-efficacy, behavior	United States	Yes

[a]Evaluated as a multicomponent program.

C, control condition; HIV, human immunodeficiency virus; I, intervention condition; STD, sexually transmitted disease; STI, sexually transmitted infection.

($n = 4$). For one study, the effects on knowledge and attitudes were combined in one single measure. Only two games[53,54] measured effects on behavior. None of the studies assessed effects on clinical outcomes. For two game studies, outcomes were measured on the same day as the intervention,[49] whereas for other game studies, measurements were conducted between 7 days to 3 months afterward. Two game studies also evaluated effects at a follow-up time and reported statistics that allowed the calculation of an effect size for this follow-up measurement.[51,53] Follow-up times varied between 30 days and one school year.

Game format

Three game studies evaluated stand-alone interventions.[49,51] Four studies evaluated games as part of a multicomponent intervention.[46,48,53,54] Multicomponent interventions were those interventions targeting more than one level of influence (e.g., peers, family, professional care) or using more than one format containing health-behavior change content (e.g., face-to-face contact). The most frequent format in these game studies was an interactive quiz, used by all seven game studies. Three game studies additionally used other formats (click-and-

(CONTINUED)

Description	Meta-analysis results	Follow-up
Women in this age group potentially face new challenges in reducing sexual risk behavior when starting a new relationship after ending their long-term relationship. This target group also shows an increased rate of STDs, of which the symptoms may be misunderstood as menopausal signs. ''Midlife Women Online'' aimed to promote sexual health behavior in this target group, by increasing knowledge about pregnancy prevention, STDs, and menopause. It furthermore intended to build skills to talk to partners and physicians about risk-reducing behaviors. The intervention was founded on the Expanded Theory of Reasoned Action, Theory of Gender and Power, Information-Motivation-Behavior Theory, and Social Learning Theory. It used input from stakeholders and target group users to create the content and user interface. The players took a quiz after watching video vignettes and received immediate feedback after every answer.	Effects were measured on knowledge, attitudes, self-efficacy, and behavioral intention. All effects were of similar small magnitude.	Yes
The game was part of a multicomponent program, also consisting of small group classroom interactions such as role-play and group discussions, and parent–child homework activities. In total, it consisted of 24 45-minute lessons. The lessons taught decision-making skills to set personal limits, to detect risk situations in which their limits would be challenged, and to protect these limits. Apart from activities directly targeting the prevention of undesired outcomes, the intervention included topics to promote sexual health behavior by engaging in healthy dating relationships. The Intervention Mapping Protocol was used to develop the program. The program was founded on several theories, namely, social cognitive theory, social influence models, and theory of triadic influence. A teen advisory board aided in the development. Several game formats were used, such as quizzes (visual and text-based), simulations (e.g., interactive, cognitive skill exercises such as moving through all the correct steps to use a condom), click-and-drag games, and arcade shooting games. The games were embedded in a virtual shopping mall, where the player could move from one store to the other to learn about sexual health issues. The content of each lesson builds on the content of the previous lesson. The activities were tailored to gender, sexual experience, and intention within particular lessons.	The game showed small effects for knowledge, self-efficacy, and behavioral intention. On the other outcomes (attitudes, subjective norm, behavior), there were no to very small negative effects.	Yes
SAHARA (SISTAS Accessing HIV/AIDS Resources At-a-click) is the computer-delivered version of an earlier intervention called SiSTA (Sisters Informing Sisters About Topics on AIDS). It aimed to prevent HIV/AIDS by increasing risk-reduction knowledge, communication and relationship skills, and condom use. Social learning theories and theory of gender and power guided the development. The SAHARA intervention combined two 1-hour computer sessions with a 15–20-minute session led by a health educator. This face-to-face session provided opportunities for role-play and immediate feedback. SAHARA had game modules or components, but it was not truly intended as a computer game. The game components mainly consisted of interactive quizzes on knowledge and skills, followed by rewards for performing a behavior correctly and by corrective feedback when behaviors were not performed correctly. Simulation role-plays to practice refusal skills for unsafe sexual requests and to practice condom use were organized in the group sessions.	Effects were large for behavior. Effects on knowledge were moderate, whereas effects on self-efficacy approximated a moderate effect.	No

drag, arcade shooter games, simulations).[49,53] Other formats, such as role-playing and simulations, were included by some ($n=3$) multicomponent interventions[46,53,54] in the nongame part of the intervention. Play duration was mentioned for four game studies[49,51,54] and ranged from 30 minutes to 2 hours.

Study design

Four studies used a pretest–posttest design with randomization at group level (e.g., schools or classes).[46,49,53] Three studies used a pretest–posttest design with a control group, randomized on an individual respondent level.[48,51,54] Most studies ($n=4$) targeting adolescents recruited their participants via schools.[46,49,53] Two studies recruited participants via admissions to a health facility,[48,54] and one study enrolled participants through self-referral after a media campaign.[51]

Game features

The game features most often used in the sexual health game studies were immediate feedback ($n=6$) and rewards ($n=5$) (Table 3). Overall, interactivity was low. Only three studies evaluated games with high interactivity. This was also evident from a frequent use of quiz formats. Three
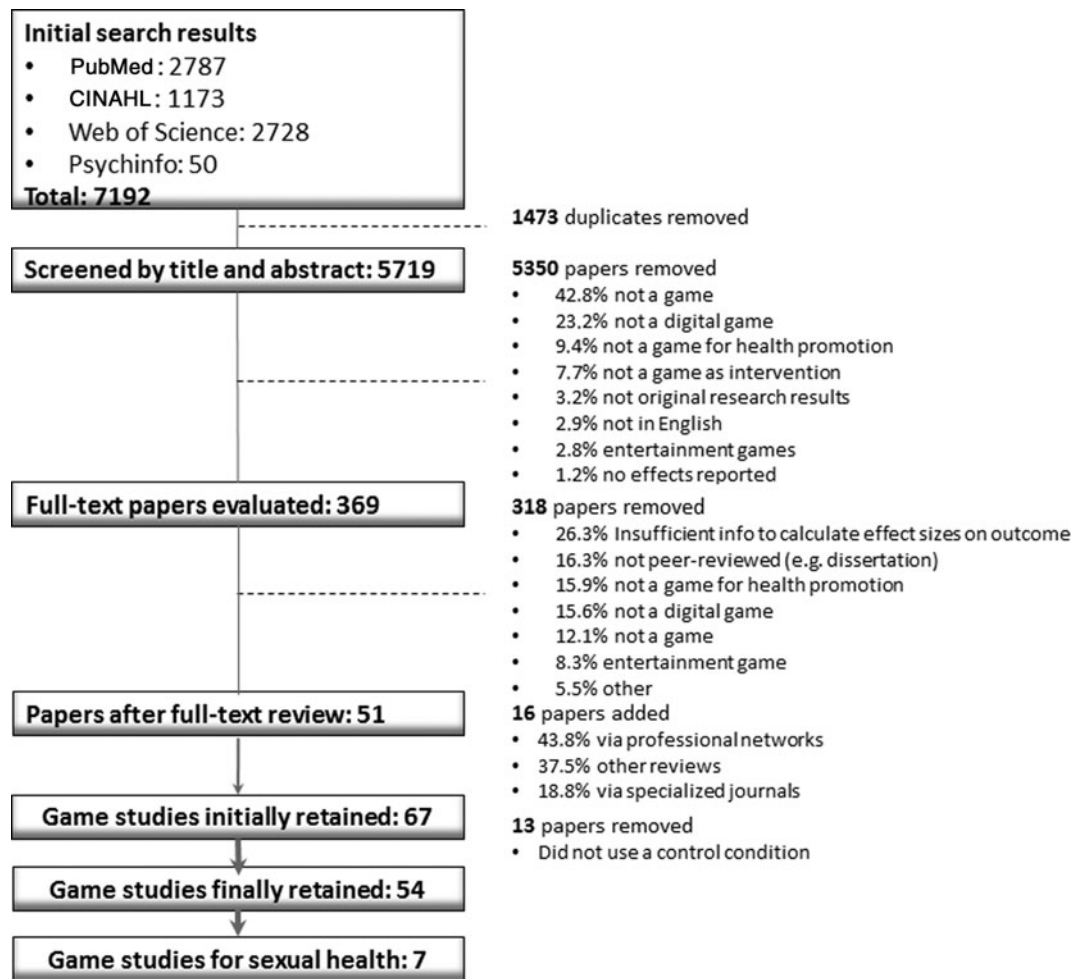
Initial search results
- PubMed: 2787
- CINAHL: 1173
- Web of Science: 2728
- Psychinfo: 50

Total: 7192

1473 duplicates removed

Screened by title and abstract: 5719

5350 papers removed
- 42.8% not a game
- 23.2% not a digital game
- 9.4% not a game for health promotion
- 7.7% not a game as intervention
- 3.2% not original research results
- 2.9% not in English
- 2.8% entertainment games
- 1.2% no effects reported

Full-text papers evaluated: 369

318 papers removed
- 26.3% Insufficient info to calculate effect sizes on outcome
- 16.3% not peer-reviewed (e.g. dissertation)
- 15.9% not a game for health promotion
- 15.6% not a digital game
- 12.1% not a game
- 8.3% entertainment game
- 5.5% other

Papers after full-text review: 51

16 papers added
- 43.8% via professional networks
- 37.5% other reviews
- 18.8% via specialized journals

Game studies initially retained: 67

13 papers removed
- Did not use a control condition

Game studies finally retained: 54

Game studies for sexual health: 7

FIG. 1.   Flowchart of study selection process.

studies used a narrative. Features such as tailoring ($n=2$), personalization ($n=2$), and scaffolding levels ($n=2$) were seldom used. Only one study had a challenge that balanced degree of difficulty and attainment, whereas none of the studies used personal goal-setting methods. Most studies ($n=5$) measured game enjoyment to some extent. The vast majority of players reported enjoying the game. Most studies ($n=5$) involved the target group in the design of the intervention (either by co-creation or by pilot-testing the game).

Meta-analysis of sexual health game effects

Effect sizes are presented separately for behavior and its determinants (Table 4). None of the games measured clinical outcomes. The average effect size for behavior at first postintervention measurement was $g=0.456$ ($k=2$; $n=1042$; 95% confidence interval, -0.649; 1.561), which was not significant. There was significant heterogeneity ($Q=33.56$, $P<0.001$). As fewer than three studies measured effects on behavior, publication bias could not be determined for this outcome.

To assess effects on behavioral determinants, first, effect sizes were averaged across all types of behavioral determinants (i.e., knowledge, attitudes, skills, self-efficacy, behavioral intention). The effect size averaged across all behavioral determinants at first postintervention measurement ($g=0.242$; $n=2425$; $k=7$; 95 percent confidence interval, 0.129, 0.356)

was positive and significant (Fig. 2). There was no significant heterogeneity ($Q=7.58$, $P=0.270$). There was, however, significant publication bias (by Egger's regression test, $t=5.75$, $P<0.01$). After correcting for publication bias using Tweedie's Trim and Fill, the average effect size was reduced to $g=0.169$ ($n=2425$; $k=7$; 95 percent confidence interval, 0.042, 0.296), which is significant, but very small.

Next, effects were examined for each specific determinant. Doing so may provide health professionals with information on how particular determinants can be influenced by serious games and can allow comparisons with other meta-analyses. Given the small number of studies per determinant and the lack of independence of data (some studies examined several determinants), we could not assess whether the effect sizes were significantly different between these determinants. Effect sizes were significant and positive for knowledge, self-efficacy, and behavioral intention but yielded nonsignificant effects for attitudes. Effects on skills were measured by only one study (Table 4). All of the effect sizes listed above can be considered small (average effect sizes exceeding 0.20 but below 0.50).

Overall effect sizes at follow-up measurement for behavior ($k=1$; $n=907$) and for its determinants ($k=2$; $n=1071$) were very small, but significant, for behavioral determinants (Table 4). There was no significant heterogeneity between the effects of these studies measuring follow-up effects on behavioral determinants ($Q=0.13$, $P=0.723$).

TABLE 3. GAME FEATURES IN SEXUAL HEALTH GAMES

Reference (year)	Involvement of target group in design	Tailoring	Personalization	Personal goal-setting	Narrative with a plot	Scaffolding levels	Optimal conflict or challenge	Interactivity/ control	Rewards	Immediate feedback	Transfer to real-life assignments	Game enjoyment
Brown et al.[46,47] (2012)	×				×				×	×	×	90 percent[a]
Marsch et al.[48] (2011)	?	×	×	?	?	×	×	?	?	?	?	3.9/5[a]
Paperny and Starn[49] ("The Baby Game") (1989a) and Starn and Paperny[50]	×				×			×	×	×		
Paperny and Starn[49] ("The Romance Game") (1989b) and Starn and Paperny[50]	×				×			×	×	×		4.3/5[a]
Swartz et al.[51] (2011)	×									×		
Tortolero et al.[52,53] (2010) and Shegog et al.[52]	×	×	×			×		×	×	×	×	64–93 percent[b]
Wingood et al.[54] (2011) and Card et al.[1]									×	×	×	4.3/5[c]
Total (n = 7)	5	2	2	0	3	2	1	3	5	6	3	

A question mark indicates missing information, as for one game study, some game features could not be coded because of insufficient information in the article.[48]

[a]Acceptance.
[b]As fun or more than other lessons or favorite videogames.
[c]Extent to which the game was considered as ''captivating.''

Discussion

This study was the first meta-analysis of serious games to investigate the effectiveness of serious games for sexual health behaviors and to examine whether immersive and health-promoting game features were incorporated in serious game interventions. In contrast to the existence of various serious digital game studies (using a control condition and measuring effects on behavior or determinants) in other areas of health promotion,[29] only a few game studies for sexual health promotion met our inclusion criteria.

Impact of serious games on sexual health behavior and its determinants

The effects on behavior after the game showed nonsignificant effects. These results were in line with nonsignificant effects from another meta-analysis on text-based messaging interventions targeting sexual health behavior effects ($d = 0.07$)[55] and with nonsignificant effects from face-to-face interventions (odds ratio = 1.03 for delay of sexual initiation; odds ratio = 1.07 for condom use).[56] The results are, however, contrary to small, significant effects found in three meta-analyses on computer-delivered interventions for safer sexual behavior[2–4] (ranging from odds ratio = 1.75 to $d_{+s} = 0.35$) and also to small, significant effects found in a meta-analysis that included both computer-delivered and face-to-face interventions ($g = 0.21$).[57] More game studies measuring behavioral effects are needed to establish their value as a tool to effectively change behavior as there were only two studies, and these showed large variations in their effects. Also, only one study included a measurement at follow-up. However, measuring behavioral effects over an extended time period is crucial to make a conclusion about the behavioral effects of serious games. This is important when assessing delayed initiation among youth, where sexual health education classes may not show their behavioral effects until youngsters are at an age where they would have naturally matured to engage in sexual behavior.

The games had a positive, albeit small, overall effect on behavioral determinants. These effects were of similar magnitude as reported for other computer-based interventions for sexual health promotion.[3] We found no significant heterogeneity among game studies in their effects averaged over these outcomes, in contrast to results reported by programs using new digital media.[58] However, few studies were included, and a larger sample may lead to more heterogeneity.

In summary, the effects of serious games on sexual health in our meta-analysis were comparable to those of other computer-delivered interventions for behavioral determinants (i.e., of a [very] small, but significant, effect size). Effects on behavior failed to reach significance and showed large confidence intervals. Because very few games for sexual health promotion met the inclusion criteria and measured behavioral effects, more research is needed to draw firm conclusions on the effectiveness of serious games on sexual health-promoting behavior.

Assessment of game characteristics

Individual tailoring directs the attention of the players to what is important for them to achieve the learning outcomes.[34,35] In games, tailoring the material also increases the extent to which learning is experienced as fun.[59] Although

TABLE 4. AVERAGE EFFECT SIZES OF SEXUAL HEALTH-PROMOTING GAMES

	k	n	Hedges' g (95% CI)	P value	Q	P value	I² (percent)
First measurement							
Behavior	2	1042	0.456 (−0.649, 1.561)	0.419	33.56	<0.001	97
Behavioral determinants	7	2425	0.242 (0.129, 0.356)	<0.001	7.58	0.270	21
Knowledge	6	1980	0.412 (0.273, 0.551)	<0.001	7.15	0.210	30
Attitudes	4	1489	0.244 (−0.027, 0.515)	0.078	10.47	<0.05	71
Self-efficacy	4	1711	0.211 (0.075, 0.346)	<0.01	4.81	0.186	38
Skills	1	56	0.396 (−0.126, 0.918)	0.137	NA		
Behavioral intention	3	1127	0.212 (0.092, 0.331)	<0.01	0.23	0.893	0
Follow-up measurement							
Behavior	1	907	0.115 (−0.019, 0.249)	0.092	NA		
Behavioral determinants	2	1071	0.148 (0.025, 0.271)	<0.05	0.13	0.723	0
Knowledge	2	1071	0.193 (0.070, 0.316)	<0.01	0.69	0.406	0
Attitudes	2	1071	0.119 (−0.003, 0.242)	0.056	0.37	0.545	0
Self-efficacy	2	1071	0.103 (−0.020, 0.225)	0.100	0.78	0.376	0
Skills	0	NA			NA		
Behavioral intention	2	1071	0.129 (0.006, 0.251)	<0.05	0.42	0.520	0

Hedges' g is a measure of random effects.
CI, confidence interval; I², inconsistency, a second measure of heterogeneity; k, number of studies; n, combined sample size; NA, not applicable; Q, homogeneity statistic (mixed effects).

individual tailoring is a common feature in computer-delivered interventions, only two included game studies used this technique. Two games may have been developed before computer-tailoring became technically possible or easily available.[49] Most of the game studies did use targeting, by examining game preferences and needs for their specific target group. Targeting refers to adapting to characteristics of a relatively homogeneous population.[60] Targeting has, however, been reported to be less effective than individual tailoring.[2] Because research has pointed to differences in preferences and needs among users of sexual health programs,[17,18] individual tailoring (e.g., by current sexual activity level) may enhance the effectiveness of sexual health games.

Challenges are what creates the excitement of a game[38] and are reported to be the main reason players like a game.[39] An optimal challenge balances difficulty and probability of obtaining the goals, which maintains a level of uncertainty of goal attainment. Games where the challenge remains absolute are less optimal to create a state of flow.[32] Adapting the difficulty

level of challenges is especially important for learning skills. Only one game, however, offered this form of adaptation (note that for the two older games, this feature may not have been technically available at the time). The included games, furthermore, devoted little attention to measuring games' effects on skill development, as also noted for sexual health promotion interventions that did not use serious games.[56] Not possessing sufficient skills can, however, be a barrier in translating positive intention into behavior,[61] and more attention may be needed here in future sexual health games.

Many intervention objectives were to increase knowledge on the consequences of risky behavior, which was typically accomplished with quizzes. It is debatable whether quizzes are suited to foster changes in other behavioral determinants. For example, role-playing and simulation games appear better suited to influence various behavioral determinants, such as knowledge, attitudes, skills, and self-efficacy.[24,38,62] In role-playing games, players acquire experience while playing as one of the game characters.[38] In simulation games, real-world

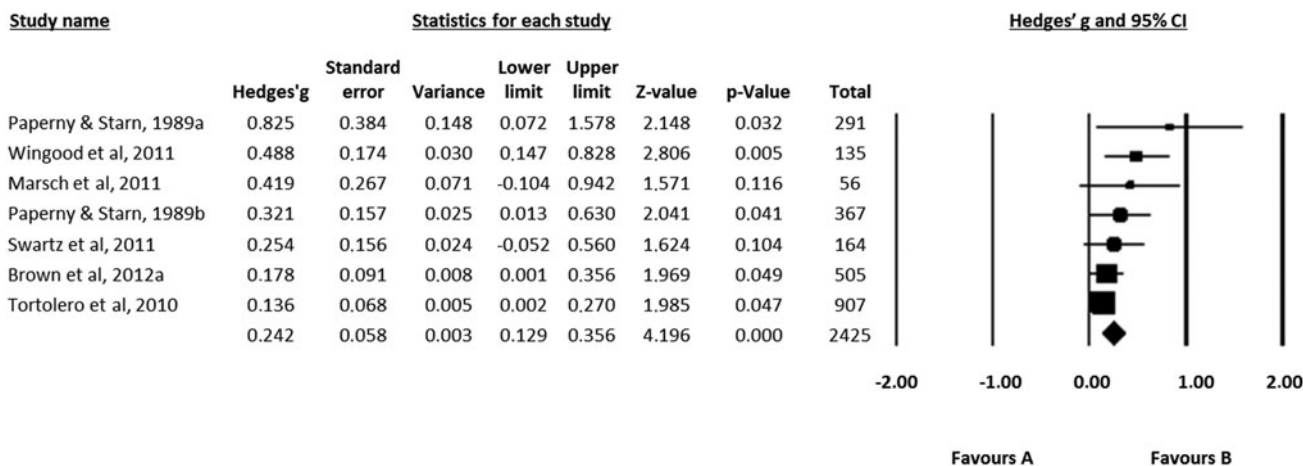| Study name	Hedges'g	Standard error	Variance	Lower limit	Upper limit	Z-value	p-Value	Total
Paperny & Starn, 1989a	0.825	0.384	0.148	0.072	1.578	2.148	0.032	291
Wingood et al, 2011	0.488	0.174	0.030	0.147	0.828	2.806	0.005	135
Marsch et al, 2011	0.419	0.267	0.071	-0.104	0.942	1.571	0.116	56
Paperny & Starn, 1989b	0.321	0.157	0.025	0.013	0.630	2.041	0.041	367
Swartz et al, 2011	0.254	0.156	0.024	-0.052	0.560	1.624	0.104	164
Brown et al, 2012a	0.178	0.091	0.008	0.001	0.356	1.969	0.049	505
Tortolero et al, 2010	0.136	0.068	0.005	0.002	0.270	1.985	0.047	907
	0.242	0.058	0.003	0.129	0.356	4.196	0.000	2425

FIG. 2. Forest plot of effect sizes averaged across behavioral determinants.[46,48,49,51,53,54] See Tables 2 and 3 for study names and descriptions. CI, confidence interval.

activities are mimicked (e.g., applying a condom, social negotiation skills) through accurate depictions of steps in that process, and opportunities are provided for practice in a safe gaming environment.[63] These formats also provide higher interactivity, which increases immersion and internalizes the learning at a higher level than when players are passively watching content and answering questions.[24] In various age groups, behavioral determinants such as self-efficacy[64,65] and perceived norms and intention[66] rather than knowledge were most strongly related to sexual risk behavior. Consequently, there is a strong need to replace or supplement quizzes with role-playing and simulation games, to address the most relevant behavioral determinants and provide a higher level of interactivity. Some of the games in our review had already implemented these game features.[49,53]

Narratives aid in fast comprehension and recollection[25] and give the player a vicarious learning experience.[24] Fewer than half of the game studies used narratives. This is regrettable, as narratives may be especially beneficial for attitude change,[67] and we found no effect in the meta-analysis of serious games on attitudes. Hence, narratives may be a fruitful approach in future sexual health game development.

The use of feedback and reward in games was found to be high. Feedback should be immediate, positive, and specific,[68] but also adapted to the player's progress and needs. Indeed, too much feedback in a game may reduce flow, and too little feedback may frustrate players.[38] Feedback should therefore support the player in his or her progression toward a goal[24,38] and provide gratification for achievements.[38] When the player is better at achieving the goal, delayed feedback may be more appropriate.[24] In our review, we were unable to determine whether feedback was adaptive in most studies. Adapting feedback to player progress and mastery level may therefore be another avenue to further game effectiveness.

In sum, most games presented little interactivity, were not tailored, not adapted to difficulty level, and did not use a narrative. Low levels of adaptations across game features may suggest that many sexual health games use a one-size-fits-all approach. Features that were frequently used were rewards and feedback. Using mostly rewards and feedback may limit the effects to merely a gamification increase in extrinsic motivation and engagement.[69] Furthermore, this approach fails to use serious game features that may result in deep learning, including insight in causal mechanisms, reasoning, using problem-solving strategies, and providing logical explanations and creating arguments for choices.[25] Taking advantage of the richness in opportunities of serious games may thus increase effects of future sexual health games. To ascertain whether these features enhance the effectiveness of sexual health games, however, moderator analyses are warranted, which could not be performed on this small sample of included games.

Target group involvement was high. Most studies also measured game enjoyment and acceptance. Formative research on both content and game mechanics is important to support self-determination needs of the target group. It also ensures health determinants at multiple levels of influence are recognized[31] and that the chosen features are perceived as immersive. This is vital as features do not universally lead to high game enjoyment for all target groups.[70] It is a positive finding that many studies in our review involved the target group in the intervention development. Future target group involvement may focus on supporting professionals in the

above-mentioned design decisions where effectiveness could be improved.[71]

Some limitations need to be noted. First, the analyses were based on a small number of game studies. Some analyses (e.g., for skills, behavior) may have been statistically underpowered, and we should be aware that "no evidence for an effect" does not equal "evidence for no effect." Furthermore, a small number of studies may underestimate the heterogeneity among studies. The limited number of studies also precluded the use of moderator analyses of game features. Second, there was significant publication bias for behavioral determinants, and, possibly, reported effect sizes were overestimated. Third, what was reported by authors as knowledge, attitudes, etc., was included as such. Different operationalizations of these constructs by authors may have affected the results. Fourth, the games included targeted only two populations—adolescents and adult women—and the reported effects may not translate to other populations. Lastly, in multicomponent interventions, the effect of the game component could not be analyzed separately from the other intervention components.

Conclusions

In summary, interventions for sexual health promotion using serious games have significant positive effects for determinants, albeit rather small. The effects on behavior, measured in only two studies, were not significant. Most games did not use many immersive game features. Instead, there was a strong reliance on pure gamification features such as reward and feedback. The effectiveness of a next generation of games for sexual health promotion may be enhanced by building further on both the behavioral change and the educational gaming literature. Future development of serious games to promote sexual health may benefit from using role-play and simulation game formats, individual tailoring to user needs, adaptation of difficulty level of the challenge, and adapting the amount and timing of feedback. Finally, there is a need for more rigorous evaluations of game effectiveness (e.g., randomized controlled trials) that provide longer-term follow-up and assess behavioral measures, rather than solely determinants.

Author Disclosure Statement

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References

1. Card JF, Kuhn T, Solomon J, et al. Translating an effective group-based HIV prevention program to a program delivered primarily by a computer: Methods and outcomes. AIDS Educ Prev 2011; 23:159–174.
2. Noar SM, Black HG, Pierce LB. Efficacy of computer technology-based HIV prevention interventions: A meta-analysis. AIDS 2009; 23:107–115.
3. Bailey JV, Murray E, Rait G, et al. Computer-based interventions for sexual health promotion: Systematic review and meta-analyses. J STD AIDS 2012; 23:408–413.

4. Portnoy DB, Scott-Sheldon LAJ, Johnson BT, Carey MP. Computer-delivered interventions for health promotion and behavioral risk reduction: A meta-analysis of 75 randomized controlled trials, 1988–2007. Prev Med 2008; 47:3–16.

5. Kharrazi H, Lu AS, Gharghabi F, Coleman W. A scoping review of health game research: Past, present, and future. Games Health J 2012; 1:153–164.

6. Shegog R. Application of behavioral theory in computer game design for health behavior change. In: Cannon-Bowers J, Bowers C, eds. *Serious Game Design and Development: Technologies for Training and Learning*. Hershey, PA: IGI Global; 2010: 196–232.

7. Baranowski T, Buday R, Thompson D, Baranowski J. Playing for real: Video games and stories for health-related behavior change. Am J Prev Med 2008; 34:74–82.

8. DeShazo J, Harris L, Pratt W. Effective intervention or child's play? A review of video games for diabetes education. Diabetes Technol Ther 2010; 12:815–822.

9. Guy S, Ratzki-Leewing A, Gwadry-Sridhar F. Moving beyond the stigma: Systematic review of video games and their potential to combat obesity. Int J Hypertens 2011; 2011:179124.

10. Kato PM. Video games in health care: Closing the gap. Rev Gen Psychol 2010; 14:113–121.

11. Papastergiou M. Exploring the potential of computer and video games for health and physical education: A literature review. Comput Educ 2009; 53:603–622.

12. Primack BA, Carroll MV, McNamara M, et al. Role of video games in improving health-related outcomes. A systematic review. Am J Prev Med 2012; 42:630–638.

13. Rahmani E, Boren SA. Videogames and health improvement: A literature review of randomized controlled trials. Games Health J 2012; 1:331–341.

14. Joinson AN. Self-disclosure in computer-mediated communication: The role of self-awareness and visual anonymity. Eur J Soc Psychol 2001; 31:177–192.

15. Baxter S, Blank L, Guillaume L, et al. Views of contraceptive service delivey to young people in the UK: A systematic review and thematic synthesis. J Fam Plann Reprod Health Care 2011; 37:71–84.

16. Charles D, McNeill M, McAlister M, et al. Player-Centred Game Design: Player Modelling and Adaptive Digital Games. 2005. http://pdf.aminer.org/000/222/654/emergent_modelling_games_development.pdf (accessed October 24, 2014).

17. Li Y, Cottrell RR, Wagner DI, Ban M. Needs and preferences regarding sex education among Chinese college students: A preliminary study. Int Fam Plan Perspect 2004; 30:128–133.

18. Newby K, Wallace LM, Dunn O, Brown K. A survey of English teens' sexual experience and preferences for school-based sex education. Sex Educ 2012; 12:231–251.

19. Nahom D, Wells E, Gillmore MR, et al. Differences by gender and sexual experience in adolescent sexual behavior: Implications for education and HIV prevention. J Sch Health 2001; 71:153–158.

20. Shrier LA, Emans SJ, Woods ER, Durant RH. The association of sexual risk behaviors and problem drug behaviors in high school students. J Adolesc Health 1996; 20:377–383.

21. Romer D, Black M, Ricardo I, et al. Social influences on the sexual-behavior of youth at risk for HIV exposure. Am J Public Health 1994; 84:977–985.

22. Brown LK, DiClemente RJ, Park T. Predictors of condom use in sexually active adolescents. J Adolesc Health 1992; 13:651–657.

23. Kotchick BA, Shaffer A, Forehand R, Miller KS. Adolescent sexual risk behavior: A multi-system perspective. Clin Psychol Rev 2001; 21:493–519.

24. Kapp KM. *The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education*. San Francisco: John Wiley & Sons; 2012.

25. Graesser A, Chipman P, Leeming F, Biedenbach S. Deep learning and emotion in serious games. In: Ritterfeld U, Cody M, Vorderer P, eds. *Serious Games, Mechanisms and Effects*. New York: Routledge; 2009: 83–102.

26. Borenstein M, Hedges LV, Higgins JPT, Rothstein HR. *Introduction to Meta-Analysis*. Chichester, United Kingdom: Wiley; 2009.

27. Higgings JPT, Green S. *Cochrane Handbook for Systematic Reviews of Interventions*. Version 5.1.0. London: The Cochrane Collaboration; 2011.

28. Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA statement. PLoS Med 2009; 6:e1000097.

29. DeSmet A, Van Ryckeghem D, Compernolle S, et al. A meta-analysis of serious digital games for healthy lifestyle promotion. Prev Med 2014; 69:95–107.

30. World Health Organization. Defining Sexual Health. Report of a Technical Consultation on Sexual Health. 28–31 January 2002, Geneva. 2006. www.who.int/reproductivehealth/publications/sexual_health/defining_sexual_health.pdf?ua=1 (accessed October 24, 2014).

31. Bartholomew LK, Parcel GS, Kok G, et al. *Planning Health Promotion Programs. An Intervention Mapping Approach*, 3rd ed. San Francisco: Jossey Bass; 2011.

32. Bedwell WL, Pavlas D, Heyne K, et al. Toward a taxonomy linking game attributes to learning: An empirical study. Simul Gaming 2012; 43:729–760.

33. Wilson KA, Bedwell WL, Lazzara EH, et al. Relationships between game attributes and learning outcomes: Review and research proposals. Simul Gaming 2009; 40:217–266.

34. Dijkstra A. Working mechanisms of computer-tailored health education: Evidence from smoking cessation. Health Educ Res 2005; 20:527–539.

35. Lustria MLA, Cortese J, Noar SM, Glueckauf RL. Computer-tailored health interventions delivered over the Web: Review and analysis of key components. Patient Educ Counsel 2009; 74:156–173.

36. Bandura A. Health promotion from the perspective of social cognitive theory. Psychol Health 1998; 13:623–649.

37. Vygotsky L. Interaction between learning and environment. In: Gauvain M, Cole M, eds. *Readings on the Development of Children*. New York: Scientific American Books; 1997: 34–41.

38. Prensky M. *Digital Game-Based Learning: Practical Ideas for the Application of Digital Game-Based Learning*. St. Paul, MN: Paragon House; 2007.

39. Bryant J, Fondren W. Psychological and communicological theories of learning and emotion underlying serious games. In: Ritterfeld U, Cody M, Vorderer P, eds. *Serious Games. Mechanisms and Effects*. New York: Routledge; 2009: 103–116.

40. Barden J, Petty RE. The mere perception of elaboration creates attitude certainty: Exploring the thoughtfulness heuristic. J Pers Soc Psychol 2008; 95:489–509.

41. Bandura A. The primacy of self-regulation in health promotion. Appl Psychol 2005; 54:245–254.

42. Hallgren KA. Computing inter-rater reliability for observational data: An overview and tutorial. Tutor Quant Methods Psychol 2012; 8:23–34.

43. Hedges L. Distribution theory for Glass's estimator of effect size and related estimators. J Educ Stat 1981; 6:107–128.

44. Higgings JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ 2003; 327: 557–560.

45. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.

46. Brown K, Newby K, Bayley J, et al. *Development and Evaluation of a Serious Game for Relationships and Sex Education Using Intervention Mapping*. Coventry, United Kingdom: Coventry University; 2012.

47. Brown K, Bayley J, Newby K. Serious game for relationships and sex education: Application of an intervention mapping approach to development. In: Arnab S, Dunwell I, Debattista K, eds. *Serious Games for Healthcare: Applications and Implications*. Hershey PA: IGI Global; 2013: 135–166.

48. Marsch LA, Grabinski MJ, Bickel WK, et al. Computer-assisted HIV prevention for youth with substance use disorders. Subst Use Misuse 2011; 46:46–56.

49. Paperny DM, Starn JR. Adolescent pregnancy prevention by health education computer games: Computer-assisted instruction of knowledge and attitudes. Pediatrics 1989; 83:742–752.

50. Starn JR, Paperny DM. Computer games enhance adolescent sex education. MCN Am J Matern Child Nurs 1990; 15:250–253.

51. Swartz LHG, Sherman CA, Harvey SM, et al. Midlife women online: Evaluation of an Internet-based program to prevent unintended pregnancy & STIs. J Women Aging 2011; 23:342–359.

52. Shegog R, Markham CM, Peskin M, et al. ''It's Your Game'': An innovative multimedia virtual world to prevent HIV/STI and pregnancy in middle school youth. Medinfo 2007; 12:983–987.

53. Tortolero SR, Markham CM, Peskin FM, et al. It's Your Game: Keep It Real: Delaying sexual behavior with an effective middle school program. J Adolesc Health 2010; 46:169–179.

54. Wingood GM, Card JF, Er D, et al. Preliminary efficacy of a computer-based HIV intervention for African-American women. Psychol Health 2011; 26:223–234.

55. Head KJ, Noar SM, Iannarino NT, Harrington NG. Efficacy of text messaging-based interventions for health promotion: A meta-analysis. Soc Sci Med 2013; 97:41–48.

56. Picot J, Shepherd J, Kavanagh J, et al. Behavioural interventions for the prevention of sexually transmitted infections in young people aged 13–19 years: A systematic review. Health Educ Res 2012; 27:495–512.

57. Becasen JS, Ford J, Hogben M. Sexual health interventions: A meta-analysis. J Sex Res 2014 September 11 [Epub ahead of print]. doi: 10.1080/00224499.2014.947399.

58. Guse K, Levine D, Martins S, et al. Interventions using new digital media to improve adolescent sexual health: A systematic review. J Adolesc Health 2012; 51:535–543.

59. Lieberman DA. Designing serious games for learning and health in informal and formal settings. In: Ritterfeld U, Cody M, Vorderer P, eds. *Serious Games. Mechanisms and Effects*. New York: Routledge; 2009: 117–130.

60. Napolitano MA, Marcus BH. Targeting and tailoring physical activity information using print and information technologies. Exerc Sport Sci Rev 2002; 30:122–128.

61. Fishbein M, Ajzen I. *Predicting and Changing Behavior: The Reasoned Action Approach*. New York: Psychology Press; 2010.

62. Baranowski T, Lieberman DA, Buday R, et al. Videogame mechanics in games for health. Games Health J 2013; 2: 194–204.

63. Apperley TH. Genre and game studies: Toward a critical approach to video game genres. Simul Gaming 2006; 37: 6–23.

64. Fernandes de Araújo L, Teva I, de la Paz Bermúdez M. Psychological and socio-demographic variables associated with sexual risk behavior for sexually transmitted infections/HIV. Int J Clin Health Psychol 2014; 14:120–127.

65. Foster V, Clark PC, Holstad MM, Burgess E. Factors associated with risky sexual behaviors in older adults. J Assoc Nurses AIDS Care 2012; 33:487–499.

66. Buhi ER, Goodson P. Predictors of adolescent sexual behavior and intention: A theory-guided systematic review. J Adolesc Health 2007; 40:4–21.

67. Lu AS, Baranowski T, Thompson D, Buday R. Story immersion of videogames for youth health promotion: A review of literature. Games Health J 2012; 1:199–204.

68. Baranowski T, Bower K, Krebs P, et al. Effective feedback procedures in games for health. Games Health J 2013; 2: 320–326.

69. Deterding S. Gamification: Designing for motivation. Interactions 2012; 19:14–17.

70. Wang H, Shen C, Ritterfeld U. Enjoyment of digital games. What makes them ''seriously'' fun? In: Ritterfeld U, Cody M, Vorderer P, eds. *Serious Games. Mechanisms and Effects*. New York: Routledge; 2009: 25–47.

71. Baranowski T, Buday R, Thompson D, et al. Developing games for health behavior change: Getting started. Games Health J 2013; 2:183–190.

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