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Review

Electronic interventions for changing knowledge, attitudes or practices regarding contraception: a systematic review

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ABSTRACT

Objectives: We conducted a systematic review of the effectiveness of electronic health education tools designed to improve knowledge, attitudes or practices related to contraception.
Methods: Eligible studies consisted of English-language reports published after 1990 that quantified the effects of an electronic intervention on any of the following outcomes: contraceptive knowledge, attitude toward contraceptives, contraceptive method choice, contraceptive use or pregnancy. We conducted a systematic search of multiple electronic databases including MEDLINE, Global Health, Academic Search Complete, Cochrane Library and Grey Literature Report. We followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines for reporting.
Results: Of 143 full-text reports assessed for eligibility, 13 studies described in 16 reports were eligible for inclusion. Of six studies that evaluated video interventions, all were randomized controlled trials, and four reported any statistically significant difference between intervention groups on knowledge, method choice or pregnancy. Of seven studies of interactive computer applications, five were randomized controlled trials, and two were nonrandomized comparison studies. Four of these seven studies found statistically significant difference between study arms in contraceptive knowledge, attitudes or contraceptive use. While most differences favored the intervention, effects were generally limited with respect to clinical relevance and the number of outcomes impacted.
Conclusions: Published assessments of electronic interventions for improving contraception-related outcomes are limited. Formal evaluations of interventions and publication of results are needed to determine the efficacy of electronic tools for contraceptive education and guide development of new interventions.

1. Introduction

Worldwide, almost half of pregnancies are unintended, with country-specific estimates ranging from 13% to 82% [1,2]. Correlates of unintended pregnancy include sociodemographic factors such as age, parity, education and economic status [2–5]. In addition to limited health care access, barriers to contraceptive use include concerns about the safety or efficacy of various contraceptive methods and lack of knowledge or access to information about contraceptives [6–12]. Many interventions designed to prevent unintended pregnancies have therefore focused on patient education and contraceptive promotion to influence knowledge about contraceptives and perceived barriers to use [13].

Common modalities for providing contraceptive education include conversations with a healthcare provider, written materials, audiovisual materials and computer applications [14,15]. With the increasing availability of mobile technologies, use of electronic platforms for the delivery of health education presents a unique opportunity for interventions to be disseminated in a variety of settings [16]. This may facilitate access to important health information, especially in resource-limited areas [16]. Reports of feasibility and patient willingness to use electronic modalities for contraceptive education are generally favorable [17–19]. However, more formal evaluations of the effectiveness of interventions delivered through electronic formats are needed.

In this review, we aimed to assess the efficacy of existing electronic tools for delivering contraceptive education. We conducted a systematic search to identify electronic interventions; described the mode of delivery and characteristics of each tool; and evaluated the effects of these interventions on outcomes of knowledge, attitudes or practices related to contraception.

2. Methods

2.1. Eligibility criteria

Eligible studies were those that quantified the effects of an electronic intervention—defined as a computer-based application or video—on a

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contraception outcome. Eligible outcomes consisted of measures of contraceptive knowledge, attitudes, method choice (i.e., intention to use a specific contraceptive method) or use, and pregnancy. Only full, published, English-language reports were eligible; abstracts and study protocols were ineligible.

Excluded studies included those that evaluated nonhuman subjects, were designed for the clinical education of healthcare providers, did not evaluate an intervention, did not include a comparison arm or were not focused on contraception (e.g., studies assessing condom use for the prevention of sexually transmitted infections). We also excluded studies in which the intervention was not electronic or the effect of an electronic component of the intervention was not evaluated separately from nonelectronic intervention components. We restricted studies to those published after 1990, given that the Internet did not become available to the general public until this time, and before August 30, 2018.

2.2. Search strategy

We conducted a systematic search of multiple electronic databases: MEDLINE through PubMed, Global Health through CAB Direct, Academic Search Complete through EBSCO and Cochrane Library. We also searched Grey Literature Report (publication produced from 1999 to 2016) for noncommercially published reports and examined the citations of review articles identified through the database search. We used the following strategy for MEDLINE:

All fields: ((computer OR application OR module OR video OR DVD OR audio OR visual) AND (education OR knowledge OR attitude OR practice OR behavior) AND (contraception OR contraceptive OR family planning OR birth control) AND English[lang] AND humans).

2.3. Data abstraction

One author (C.D.) screened the titles and abstracts of all reports identified through the electronic search. Two authors (C.D. and J.S.) independently reviewed full-text reports for eligibility and completed subsequent data abstraction from eligible reports using a standardized form. To ensure accuracy, the two authors compared results and, in the event of a discrepancy, consulted with a third author (M.G.) until consensus was reached.

Information extracted from eligible reports included (1) study design; (2) study location; (3) participant age range; (4) number of participants randomized and analyzed; (5) study site (e.g., school, family planning clinic); (6) intervention type (video or interactive); (7) mode of control (e.g., electronic, brochure, standard care); (8) intervention intensity (one or multiple sessions) and (9) outcomes assessed (knowledge, attitude, method choice, contraceptive use or pregnancy).

2.4. Statistical analysis

We report relevant effect measures, which could be unadjusted or, if available from the original reports, adjusted for confounders. We used the risk of bias assessment as described in the Cochrane Handbook for Systematic Reviews of Interventions as a guide [20]. We did not combine findings into a meta-analysis due to heterogeneous study populations and outcome measures reported.

3. Results

3.1. Characteristics of eligible studies

After removing 371 duplicates, the database search yielded 3449 records for title and abstract screening (Fig. 1). Examination of the references of review articles resulted in an additional seven reports for consideration. A total of 143 records required full-text review to determine eligibility. Thirteen studies, described in 16 reports, were eligible for inclusion (Table 1) [21–36].

Of the 13 studies, 8 evaluated knowledge, 3 evaluated attitudes, 5 evaluated method choice, 5 evaluated contraceptive use, and 4 evaluated pregnancy (Tables 2 and 3). Most studies involved an electronic intervention at the point of care, with a control or comparison group receiving standard care or a noncontraceptive intervention; a smaller proportion recruited and implemented their studies in nonclinical sites (Table 1). Of eight studies reporting a significant intervention effect for any of the outcomes of interest, five were randomized controlled trials (RCTs) with moderate-quality evidence, one was an RCT with low-quality evidence, and two were nonrandomized comparison studies with low-quality evidence (Table 4) [21,22,24–26,29,31,34,36].

3.2. Contraceptive knowledge: RCTs

Among six RCTs that assessed contraceptive knowledge [21–24,32,36], two found evidence of improved knowledge for those receiving the electronic intervention. Mason et al. conducted a pilot study of a video intervention designed to increase knowledge about female sterilization among women requesting the procedure at outpatient gynecology clinics in the United Kingdom (UK) [21]. Knowledge regarding the sterilization procedure and alternatives was assessed. Higher median knowledge scores were reported in the intervention group compared to the control group (90.0% and 57.5%, respectively; $p<.01$). The intervention group received the video followed by standard consultation with a healthcare provider, while the control group received a standard consultation only. The video was 5 min in length and included an overview of the procedure in addition to information about failure rates, risks, benefits and alternatives to sterilization. Knowledge scores were evaluated immediately postintervention. In a pilot study of a video intervention providing information about a specific contraceptive implant to women seeking abortion in the UK, Michie et al. reported that those in the control group who only received information from a healthcare provider were more likely to incorrectly believe that mood or skin changes are common side effects of the implant (53.3%) compared to those in the video intervention group (5.7%; $p<.01$) [22]. However, no other significant differences in information recall (measured immediately postintervention) between groups were found. Other measured knowledge items included additional side effects, the mechanism of action and limits related to the duration of the implant. The DVD was 9 min in length and included information about the mechanism of action, insertion and removal procedures, contraindications and risks. Women in the intervention group were also given the opportunity to discuss questions with a healthcare provider following the video.

A study of women hospitalized for childbirth in Columbia evaluated a contraceptive counseling video compared to receiving the same information in a face-to-face conversation with a counselor [36]. The video featured a nurse providing standard contraceptive information and was approximately 14 min in length. The intervention group also had the opportunity to discuss contraceptive options with a counselor, and both groups received written educational materials. No statistically significant differences in knowledge (measured immediately postintervention) were found between groups except for knowledge of the definition of family planning, in which the effect favored receipt of information from a counselor ($p=.01$ in postintervention group comparison). Other measured knowledge items focused on the efficacy of various contraceptive methods.

Three other RCTs evaluated contraceptive knowledge and found no significant intervention effects: for a study of middle-aged women (40–55 years) based in the United States (US), Swartz et al. found no significant differences in knowledge scores between those viewing an internet-based multimedia program about pregnancy and sexually transmitted infection (STI) prevention with videos about contraception and controls viewing a website with reproductive health content [23]. A majority of measured knowledge items related to pregnancy prevention

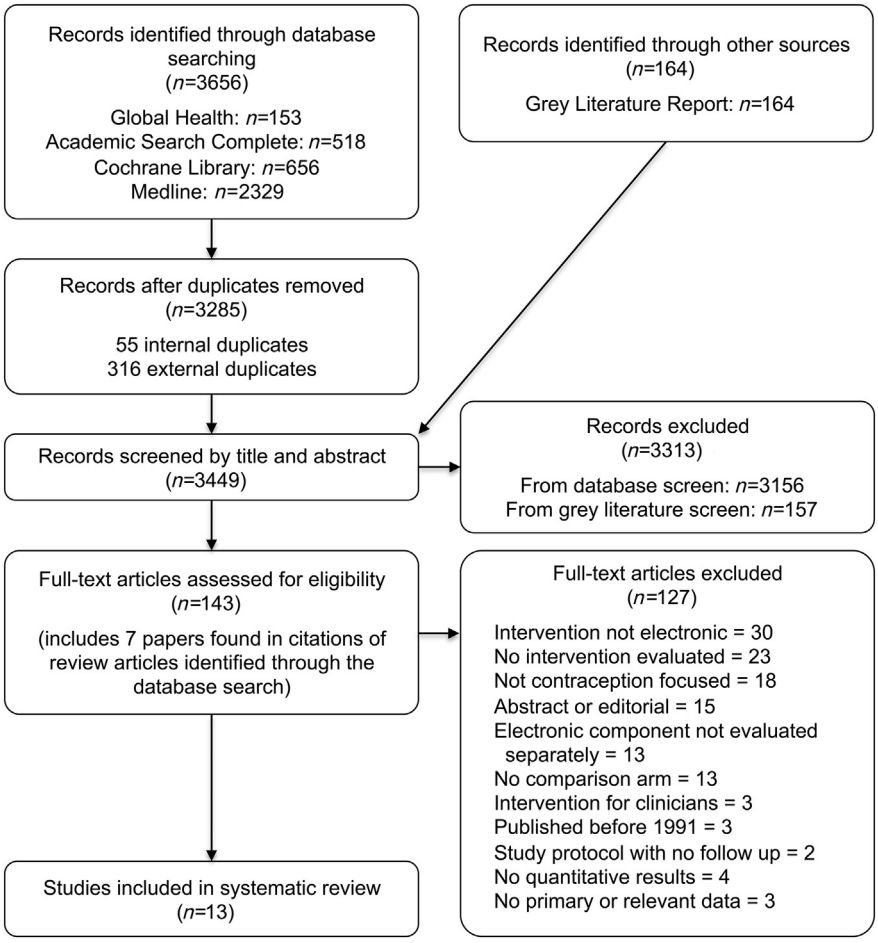

Fig. 1. Flow diagram of report eligibility.

and were assessed at 7- and 30- day follow-up. Schwarz et al. evaluated an interactive computer program within urban acute care settings in the US [24]. The intervention was designed to increase knowledge and use of hormonal contraception among women and was delivered on a waiting room kiosk. There were no significant differences in knowledge scores at 3-month follow-up for women receiving contraceptive information and women assigned to a control program about chlamydia screening, though the study authors noted limited power to detect effects related to knowledge. Finally, Sridhar et al. evaluated a mobile app-based intervention designed to improve knowledge of reversible contraceptive methods [32]. The study was conducted among women at an obstetrics and gynecology clinic in the US. Knowledge of long-acting reversible methods was assessed immediately postintervention and did not significantly differ between women who received the app-based intervention and controls receiving information from a health educator. The intervention was delivered on an iPad and included information on 10 different reversible contraceptive methods with a focus on long-acting reversible contraceptives (LARC). Information about each method included mechanism of action, efficacy, benefits, risks and side effects.

Table 1
Characteristics of included studies of electronic interventions for changing knowledge, attitudes or practices regarding contraception ($n=13$).*a

Characteristics		n
Study design		
	Randomized controlled trial	11
	Nonrandomized comparison	2
Country[a]		
	United States	8
	United Kingdom	2
	Brazil	1
	Colombia	1
	Kenya	1
	Zambia	1
Site		
	Family planning clinic	2
	Abortion clinic	2
	Outpatient obstetrics/gynecology clinic	2
	STI/HIV clinic	1
	School	1
	Hospital	1
	Multiple sites	2
	Other	2
Intervention type		
	Video	6
	Interactive computer-based application	7

[a] Countries sum to 14 as one study was conducted at two sites: Brazil and Kenya [25].

3.3. Contraceptive knowledge: nonrandomized comparison studies

Two nonrandomized studies assessed contraceptive knowledge [25,26]. Chewning et al. evaluated a computer-based contraceptive decision aid administered to adolescent women attending family planning clinics in Madison, WI, and Chicago, IL, in the US [26]. The program was menu driven and included information about the mechanism of action, efficacy, benefits and side effects of contraceptive methods. While using the program, users could type questions to discuss with their healthcare provider. Participants received a printed copy of these questions along with a summary of steps for effective method use and

Table 2
Description and key results of video interventions for changing knowledge, attitudes or practices regarding contraception

Study	Number randomized (*N*)	Site location and study population	Intervention	Comparison	Outcomes	Main findings
RCTs						
Davidson et al. (2015) [27]	193	Single abortion clinic in Chicago, IL, USA. Population: female postabortion patients ages 18–29.	Video based on the transtheoretical model of behavior change; designed to promote LARC initiation postabortion; delivered on iPad; 7-min duration; followed by standard care (contraception counseling by healthcare provider)	Video about stress management; 7-min duration; followed by standard care (contraception counseling by healthcare provider)	Method choice (LARC selection immediately postabortion)	No significant difference between groups: LARC method selected by 59.4% in intervention group and 51.6% in control group (p=.28); the study authors note limited power to detect this effect
Hersh et al. (2018) [36]	240	Two sites: public, urban maternity care hospitals. Medellín, Antioquia, and Cartagena, Bolívar, in Columbia. Population: female postpartum patients.	Video of a nurse providing standard contraceptive information; ~14-min duration; followed by opportunity to discuss contraceptive options with a counselor; participants also given written materials	Structured face-to-face conversation with a counselor; participants also given written materials	Knowledge (about family planning); evaluated immediately postintervention	For six of seven knowledge questions, the number of correct responses postintervention did not significantly differ between groups. In the conversation group, 100% (119/119) of participants responded correctly to the question of "What is family planning?" compared to 95.0% (114/120) of those in the video group (p=.01)
					Method choice (intended postpartum contraception); evaluated immediately postintervention	No significant difference between groups in intended contraception (p=.18) or tier change for intended method (p=.13)
Mason et al. (2003) [21]	31 (pilot)	Two gynecology outpatient clinics at teaching hospitals in Nottingham, UK. Population: adult women, ages not specified.	Educational video about female sterilization (including overview of procedure, failure rate, risks and alternatives); 5-min duration; followed by standard consultation with healthcare provider	Standard consultation with healthcare provider	Knowledge (sterilization procedure and alternatives); evaluated immediately postintervention	Overall, the intervention group had significantly higher median knowledge scores compared to the control group (p<.01)
Michie et al. (2016) [22]	50 (pilot)	Single abortion clinic in Edinburgh, UK. Population: female preabortion patients at least 16 years old.	DVD about the contraceptive implant Nexplanon (including mechanism of action, insertion/removal, contraindications and risks); for women seeking abortion; 9-min duration; followed by opportunity to discuss with healthcare provider	Nexplanon information given by healthcare provider	Knowledge (information recall); evaluated immediately postintervention	No significant difference in recall between groups, except for knowledge of side effects: the control group was more likely to believe (incorrectly) that mood and/or skin changes are common side effects of the medication (p<.01)
					Contraceptive use (implant insertions); evaluated 3 months postintervention	Of 38 women interviewed at follow-up, 34 had an implant inserted: 25 (92.6%) in the treatment group and 9 (81.8%) in the control group (p=.31)
Stephenson et al. (2011) [31] [additional reports: Wall, Haddad, et al. (2013) [33] & Wall, Vwalika et al. (2013) [34]]	1502	Multiple freestanding clinics in Lusaka, Zambia. Population: HIV serodiscordant and concordant heterosexual couples.	Three video interventions: (1) methods-based video (contraceptive methods with emphasis on IUD and implant), (2) motivational video (demonstrating ideal planning behaviors including those related to pregnancy prevention) or (3) combination of methods and motivational videos; 30-min duration; provided to HIV serodiscordant and concordant positive couples	Videos about handwashing, bednets and good nutrition	Method choice; evaluated immediately postintervention	Compared to the control group, couples in the methods-only group were more likely to select injection versus the oral pill (RR=1.55, 95% CI: 1.03–2.34). Those in the combination group were more likely to select injection versus the oral pill compared to the control group (RR=1.65, 95% CI: 1.07–2.55) and twice as likely to select IUD, Norplant or tubal ligation versus the oral pill (RR=2.06, 95% CI: 1.17–3.44)

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Table 2 (*continued*)

Study	Number randomized (*N*)	Site location and study population	Intervention	Comparison	Outcomes	Main findings
					Pregnancy; time to unintended pregnancy among OCP users	No significant difference between control versus methods video (HR=1.03, 95% CI: 0.71–1.50) or control versus motivational video (HR=1.13, 95% CI: 0.79–1.61). The authors report interaction of both videos did not affect time to unintended pregnancy.
					Pregnancy; time to unintended pregnancy	No significant differences between groups among those not using contraception at baseline. For baseline contraceptive users, the methods video group experienced increased time to pregnancy versus the control and/or motivational video (HR=0.38, 95% CI: 0.19–0.75)
Swartz et al. (2011) [23]	422	Conducted online, USA. Population: Women ages 40–55 years.	Internet-based multimedia program including video modules with contraception content	Website with reproductive health content	Knowledge; evaluated at 30-day follow-up	Adjusted for pretest scores. No statistically significant differences in scores between treatment groups (p=.30)
					Attitude (related to contraception issues presented in program); evaluated at 30-day follow-up	Adjusted for pretest scores. No statistically significant differences in scores between treatment groups (p=.54)

CI = confidence interval; HR = hazard ratio; IUD = intrauterine device; LARC = long-acting reversible contraception; OC = oral contraception; RR = risk ratio.

individualized suggestions for improving the efficacy of contraceptive methods. Oral contraceptive knowledge related to benefits, side effects and actions to take in the event of missed pills was assessed. Mean knowledge scores were significantly higher at both study sites immediately postintervention for those receiving the intervention (in addition to standard patient education) compared to those receiving standard education only (p<.01). However, at 1-year follow-up, this difference remained at the Madison site only. Halpern et al. evaluated a series of web-based modules about reproductive health among adolescent males and females at schools in Nairobi, Kenya, and Rio de Janeiro, Brazil [25]. Comparison schools received other electronic equipment (television, video cassette recording or photocopier) but did not have web access. At both sites, intervention effects on knowledge about emergency contraception (EC) varied by gender (Table 3). For example, in Nairobi, girls in intervention schools were less likely to know the window for the effectiveness of EC relative to girls in comparison schools [odds ratio (OR) =0.60; 95% confidence interval (CI): 0.43–0.82], while for boys, those in intervention schools were more likely to correctly identify the effectiveness window (OR= 1.40; 95% CI: 1.26–1.58). Importantly, the authors noted that these mixed results may be attributed to inadequate (or differential) exposure to the project website: student use of computers was not supervised or quantified, but available evidence shows that students visited other websites in addition to the project site. Lastly, an additional feature was embedded within the intervention at the site in Rio de Janeiro: half of students responding incorrectly to a question about the duration of EC effectiveness within the five web-based modules were randomly selected to receive a pop-up window showing the correct answer. Intervention students at this location were more than twice as likely to know how long EC remains effective relative to students in comparison schools (OR=2.25; 95% CI: 1.61–3.14).

3.4. Attitudes toward contraception: RCTs

One US-based study evaluated attitudes toward contraception among women ages 40–55 years following their participation in an interactive internet-based multimedia program containing contraceptive content [23]. A composite score of participant attitude was derived from measurements of the perceived importance of the following items: using a contraceptive method to prevent pregnancy, discussing contraception with a partner, using a contraceptive method to prevent sexually transmitted infections and talking with a healthcare provider. After 7 days, participants in the intervention group scored significantly higher on the perceived importance of these items than control participants who viewed a website with reproductive health content (p=.03). However, these effects did not persist to the 30-day follow-up (p=.54).

3.5. Attitudes toward contraception: nonrandomized comparison studies

Two nonrandomized studies assessed attitudes toward contraceptive use [25,26]. Chewning et al. assessed confidence in oral contraceptive efficacy among adolescent women attending family planning clinics in the US [26]. A higher proportion of those who used a computerized contraceptive decision aid (in addition to receiving standard patient education) perceived oral contraception to be effective compared to those receiving standard care only (p<.01 for both study sites immediately postintervention). However, by 1-year follow-up, the differences in group perceptions of oral contraceptive effectiveness were no longer statistically significant.

A web-based reproductive health education program in Nairobi, Kenya, and Rio de Janeiro, Brazil, evaluated perceived barriers to condom use among adolescent male and female students [25]. In Nairobi, intervention students were less likely than comparison students to

Table 3
Description and key results of interactive computer-based interventions for changing knowledge, attitudes or practices regarding contraception

Study	Number randomized (*N*)	Site location and study population	Intervention	Comparison	Outcomes	Main findings
RCTs						
Gilliam et al. (2014) [28]	62 (pilot)	One Title X clinic in Chicago, IL, USA. Population: Title X patients presenting for contraceptive services, ages 15–30.	iOS application about contraceptive methods; included videos of peer testimonials about LARC; administered on tablet in waiting room; up to 15-min duration; followed by standard care	Standard care	Method choice (LARC selection); obtained through chart review 1 month postintervention	No significant difference in LARC selection between groups (ITT analysis: 22.6% in intervention group versus 25.8% in control group, p=.77)
Ingersoll et al. (2018) [35]	75 (pilot)	Conducted online, USA. Population: women ages 18–44.	Series of six web-based modules containing information about alcohol-exposed pregnancy, contraception and risky drinking; modules included videos, were interactive and contained feedback elements	Website containing intervention content but without tailored information or feedback elements	Contraceptive use (episodes of sex unprotected by contraception); evaluated at 9-week and 6-month follow-up	In the intervention group, 83.6% reported unprotected sex at baseline, 63.2% at 9-week follow-up and 47.6% at 6-month follow-up. In the control group, 61.9% reported unprotected sex at baseline, 58.5% at 9-week follow-up and 47.6% at 6-month follow-up (p=.05 for group by time test)
Peipert et al. (2008) [29] [additional reports: Peipert et al. (2011) [30]]	542	Providence, RI, USA. Population: women ages 13–35.	Multimedia computer program based on the transtheoretical model of behavior change; designed to promote dual methods of contraception; provided tailored feedback to participants appropriate for their current stage of change; participant received printed feedback report; 3 sessions over 80 days	One computer session (not individualized or tailored) including standard contraceptive and STI prevention information; received nontailored educational pamphlets	Contraceptive use (any dual method use); evaluated at 24-month follow-up	Adjusted for propensity score (in propensity score model, the authors report inclusion of multiple factors related to the risk of pregnancy and STI, including sexual behavior, sexual history, smoking, and alcohol and substance abuse). Those in the intervention group were more likely report any use of dual methods compared to the control group (HR=1.70, 95% CI: 1.09–2.66); the study authors note limited power to detect effects of interest due to increased condom use in the control arm
					Pregnancy; evaluated at 24-month follow-up	Adjusted for any dual method use and propensity score (in propensity score model, the authors report inclusion of multiple factors related to the risk of pregnancy and STI, including sexual behavior, sexual history, smoking, and alcohol and substance abuse). No difference in rates of unplanned pregnancy between groups (HR=1.22, 95% CI: 0.73–2.04) for intervention versus control group; the study authors note limited power to detect effects of interest due to increased condom use in the control arm
					Contraceptive use (adherence to dual method use); evaluated at 24-month follow-up	Adjusted for education, substance abuse, contraceptive use at baseline and stages of change. No difference in sustained use of dual methods between groups (RR=0.89, 95% CI: 0.45–1.75) for intervention versus control group

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Table 3 (*continued*)

Study	Number randomized (*N*)	Site location and study population	Intervention	Comparison	Outcomes	Main findings
Schwarz et al. (2013) [24]	814	Three emergency departments and one urgent care clinic in Western PA, USA. Population: women ages 18–45.	Use of an interactive computer program at a kiosk; provided information about contraceptives and allowed participants to request a prescription for a contraceptive	Kiosk module providing educational information about chlamydial infection screening	Knowledge (about contraception); evaluated at 3-month follow-up	No significant differences in knowledge scores; the study authors note limited power to detect effects related to knowledge
					Contraceptive use; evaluated at 3-month follow-up	For women in the intervention group, 16.2% received a prescription for hormonal contraception at the time of the visit compared to 1.3% in the control group ($p<.01$). At 3-month follow-up, there was no statistically significant difference in contraceptive use between groups with 70.9% of those in the intervention group reporting use of any form of birth control at last sexual encounter compared to 65.0% in the control group ($p=.91$)
					Pregnancy; evaluated at 3-month follow-up	No significant difference in unintended pregnancy between groups. Among women reporting sex in the 3 months following care, 0.9% (1/117) in the intervention group experienced an unintended pregnancy compared to 3.8% (3/80) in the control group ($p=.31$).
Sridhar et al. (2015) [32]	120	One university obstetrics and gynecology clinic in Los Angeles, CA, USA. Population: women ages 18–45.	Mobile app delivered on iPad tablet; provided contraceptive information for 10 nonpermanent methods with a focus on LARC; information included mechanism of action, effectiveness and side effects	Contraception information provided by a health educator	Knowledge (of chosen contraceptive method); evaluated immediately postintervention	Mean knowledge scores of very effective contraceptive methods (IUD or implant) were evaluated; no significant differences between groups ($p=.30$)
					Method choice (selection of IUD or implant); evaluated through medical chart review after clinical visit	In the intervention group, 51.7% chose IUD or implant compared to 56.7% in the control group ($p=.75$)
Nonrandomized comparison studies						
Chewning et al. (1999) [26]	Nonrandomized study; in Madison, 500 participants selected and in Chicago, 449 participants selected	One family planning clinic in Chicago, IL, and two in Madison, WI, USA. Population: women ages 20 years or younger.	Computer-based contraceptive decision aid; designed for adolescents; menu driven: patient selects contraceptive method to view information; 15–20-min duration; receipt of printed feedback related to effective method use; provided in addition to standard patient education	Standard patient education	Knowledge (of OCP); evaluated at 1-year follow-up	Madison site: mean knowledge scores were higher in the intervention group compared to the control group ($p=.03$). Chicago site: mean knowledge scores did not differ significantly between groups
					Attitude (perceived efficacy of OC); evaluated at 1-year follow-up	Both sites: no significant difference between groups
					Contraceptive use (OC nonadoption); evaluated at 1-year follow-up among women expressing intention to adopt OCs, as well as	Madison site: no significant difference in OC nonadoption between groups. Chicago site: 3.4% OC nonadoption in the intervention group

Table 3 (*continued*)

Study	Number randomized (*N*)	Site location and study population	Intervention	Comparison	Outcomes	Main findings
					months on OC among OC users	compared to 8.8% in the control group (p=.05). Among OC adopters, no significant difference in months of OC use between groups
					Pregnancy; evaluated at 1-year follow-up	Madison site: the intervention group reported a lower percentage of pregnancies (3.6%) compared to control group (8.6%) (p=.07). Chicago site: also no significant difference between groups; the study authors note limited power to detect this effect of interest
Halpern et al. (2008) [25]	Nonrandomized study; in Kenya, 1530 students started modules and in Brazil, 1412 students started modules	One school each in Nairobi, Kenya, and Rio de Janeiro, Brazil. Population: male and female high school students.	Series of five web-based modules about reproductive health; designed for adolescents; one module administered every 6–8 weeks; two study sites: Nairobi and Rio; at Rio location, half of students responding incorrectly to a question about the duration of EC effectiveness received a pop-up screen with the correct answer provided	Students in comparison schools received electronics but no internet access.	Knowledge (about EC); evaluated in final module	Adjusted for knowledge at module 1, age, gender and socioeconomic status. Nairobi site: Knowledge about EC varied by gender: girls did not differ by group in knowledge of the definition of EC, but girls in the intervention group were less likely to know when EC is effective compared to the control group (OR=0.60, 95% CI: 0.43–0.82). Boys in intervention group were more likely to know what EC is compared to the control group (OR=1.99, 95% CI: 1.55–2.54) and also more likely to know when EC is effective (OR=1.40, 95% CI: 1.26–1.58). Rio site: for girls, there were no differences by group in knowledge of the definition of EC. For boys, those in the intervention group were less likely to know what EC is compared to the control group (OR=0.49, 95% CI: 0.31–0.75). Overall, students in the intervention group were more likely to know when EC remains effective (OR=2.25, 95% CI: 1.61–3.14)
					Attitude (perceived barriers to condom use); evaluated in final module	Adjusted for attitude at module 1, age, gender and socioeconomic status. Nairobi site: Students in the intervention group were more likely to disagree that condoms often break compared to the control group (OR=1.64, 95% CI: 1.07–2.54), but less likely to disagree that condoms are too expensive (OR=0.72, 95% CI: 0.60–0.88) or embarrassing to discuss (OR=0.71, 95% CI: 0.60–0.86). Rio site: Students in the intervention group were more likely to disagree that condoms often break compared to the

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Table 3 (*continued*)

Study	Number randomized (*N*)	Site location and study population	Intervention	Comparison	Outcomes	Main findings
						control group (OR=1.44, 95% CI: 1.06–1.95) and less likely to disagree that condoms are embarrassing to use (OR=0.44, 95% CI: 0.26–0.74). For perceived difficulty of condom use, the intervention effect varied by age and gender. Girls in the intervention group were more likely to disagree that condoms are difficult to use compared to the control group (OR=1.41, 95% CI: 1.16–1.71), whereas boys in the intervention group were less likely to disagree with this statement compared to the control group (OR=0.38, 95% CI: 0.24–0.58)

disagree that condoms are "too expensive" or "embarrassing to talk about" (OR=0.72; 95% CI: 0.60–0.88 and OR=0.71; 95% CI: 0.60–0.86, respectively) and more likely to disagree that condoms often break (OR=1.64; 95% CI: 1.07–2.54). These effects did not vary by gender. In Rio de Janeiro, intervention students were less likely to disagree that condoms are embarrassing to use compared to the comparison group (OR=0.44; 95% CI: 0.26–0.74) and more likely to disagree that condoms often break (OR=1.44; 95% CI: 1.06–1.95). Girls in the intervention group were more likely than the comparison group to disagree that condoms are difficult to use (OR=1.41; 95% CI: 1.16–1.71), while boys in the intervention group were less likely than the comparison group to disagree with this statement (OR=0.38; 95% CI: 0.24–0.58).

3.6. Contraceptive method choice: RCTs

Of five RCTs that examined contraceptive method choice [27,28,31,32,36], only one reported statistically significant differences in method selection between intervention groups. Stephenson et al. evaluated three different video interventions among HIV serodiscordant and concordant positive heterosexual couples in Zambia: one video focused on contraceptive methods, one focused on motivation by modeling planning behaviors (including those related to pregnancy prevention) and one featured a combination of both videos [31]. Participants who viewed the methods-focused video were more likely to choose injectable contraceptives than oral contraceptives compared to participants who viewed a control video with general education messages about handwashing, bednets and nutrition [risk ratio (RR) =1.55, 95% CI 1.03–2.34]. Participants who viewed the combination method and motivational videos were also more likely to choose injectable contraceptives compared to the control group (RR=1.65, 95% CI 1.07–2.55) and additionally more likely to select intrauterine device (IUD), implant or tubal ligation than an oral pill (RR=2.06, 95% CI 1.17–3.44). Method choice was evaluated immediately postintervention.

None of the other four RCTs that assessed method choice reported significant differences between intervention groups. In an evaluation of a video designed to promote LARC initiation among women undergoing surgical abortion at a clinic in the US, Davidson et al. reported no significant difference in LARC selection postabortion between participants assigned to the intervention video and those assigned to a control video about stress management (p=.28) [27]. However, the study authors noted limited power to detect this effect given a higher baseline rate of LARC initiation than anticipated at the study site. The video was 7 min in length and included information on three LARC methods delivered by a healthcare provider as well as narrative comments from patients who had used LARC after surgical abortion. Both groups also received contraceptive counseling from a healthcare provider. For a mobile contraceptive counseling app that provided information on 10 different reversible contraceptive methods with a focus on LARC, no significant difference in selection of an IUD or implant was reported between women assigned to the mobile app and women receiving contraceptive information from a health educator (p=.75) [32]. The study was conducted at an obstetrics and gynecology clinic in the US, and method choice was determined through medical chart review following the clinic visit. In a pilot study of a tablet-based contraceptive counseling app administered to women in three family planning clinics in the US, no difference in LARC selection was reported for those using the app in the waiting room (followed by standard care) compared to those receiving standard care only [28]. The self-navigating app featured comparisons of the effectiveness of contraceptive methods, answers to method-specific questions and videos of peer testimonials about LARC. Method choice was determined through chart review 1 month postintervention. Finally, in an evaluation of receiving initial contraceptive information by video or through face-to-face counseling among women hospitalized for childbirth in Columbia, there were no significant differences between groups in intended contraception (p=.18) or tier change in intended method (p=.13) [36]. Women in the video intervention group also had the opportunity to discuss contraceptive options with a healthcare provider. Method choice was evaluated immediately postintervention.

3.7. Contraception use: RCTs

Four RCTs evaluated contraceptive use [22,24,29,30,35]. One study developed an interactive computer program displayed on kiosks in acute care settings in the US. Women in the intervention group received information about contraception and had the ability to request a prescription for a contraceptive, while women in the control group only received information about chlamydia screening. [24]. At the time of their appointment, intervention participants were more likely to request a prescription for contraception compared to participants in the control group (p≤.01). However, at 3-month follow-up, there was no significant difference in self-reported contraceptive use at the time of last intercourse between groups (p=.91). Peipert et al. evaluated a multimedia program based on the transtheoretical model (TTM) of behavior change and designed to promote dual-method contraception. In this US-based study, women in the intervention group receiving tailored feedback based on their assessed stage of change reported increased initiation of dual-method use by 24-month follow-up compared to women in the control group receiving standard information with no tailored feedback [hazard ratio (HR) = 1.70, 95% CI, 1.09–2.66] [29]. However,

Table 4
Assessment of potential bias in included studies of electronic interventions for changing knowledge, attitudes or practices regarding contraception

Low risk
High risk
Unclear

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Chewning et al. (1999)	Quote: "…every other patient was assigned to the control verses the experimental group as much as possible within clinic schedules."	Non-random predictable sequence	Unclear if participants or research team blinded	No evidence of blinding. Scale used to measure knowledge and the authors report a clearly defined question to obtain efficacy information. For other outcomes, it is unclear whether a standardized interview form was used	Madison site: a total of 500 participants selected with 449 participants (90%) completing the 12 month follow-up. Chicago site: a total of 449 participants selected with 335 participants (75%) completing the 12 month follow-up. Regarding differential attrition, quote: "The Time-3 follow-up interviewers reached 90% of the Madison patients interviewed at Time-1 and reached 70% in Chicago where disconnected phone numbers and changed addresses were more common." Unclear if attrition also differed by study arm		Non-randomized study
Davidson et al. (2015)			Participants not blinded. Member of research team present during video (not blinded). Counselors and clinicians blinded to intervention allocation but not to patient participation in study. Successful blinding of clinic counselors formally evaluated	No evidence of blinding, though outcome measurement unlikely to be influenced; contraceptive method choice determined through chart review	A total of 193 participants randomized and 191 participants analyzed: 96 in the intervention group and 95 in the control group		Authors report that in both study arms, the rate of LARC initiation was over two times the rate of LARC initiation among eligible women who did not participate in the study (55% vs. 20%, respectively)

participants in the intervention group were not more likely to have self-reported sustained dual-method use at 24 months (RR=0.89, 95% CI: 0.45–1.75) [30]. The authors noted limitations in power to detect effects of interest due to increased use of condoms in the control arm. Ingersoll et al. conducted a pilot study to evaluate an interactive internet-based intervention for reducing the risk of alcohol-exposed pregnancy among women with risky drinking behaviors in the US [35]. The intervention site contained six modules with information about alcohol-exposed pregnancy, contraception and risky drinking, and contained feedback elements including affirmations following completed steps and graphical feedback of progress in completing online diary entries. An untailored website containing the same content but without feedback served as the control. Both groups demonstrated reduced rates of self-reported sex unprotected by contraception at 9 weeks posttreatment and at 6-month follow-up. A higher proportion of participants in the intervention group reported unprotected sex episodes at baseline (83.6% compared to 61.9% in the control group), and by 6-month follow-up, the proportion of reported unprotected sex was the same in both groups (47.6%) (p=.05 for group by time test). Finally, in a pilot study conducted in the UK among women requesting an abortion,

Table 4 (*continued*)

Gilliam et al. (2014)	■	■	■ Unclear if participants blinded. Counselors and clinicians blinded to intervention allocation	■ Contraceptive method choice determined through chart review by clinic staff. It appears that clinic staff (blinded) then relayed information to the research team. Quote: "After the visit, clinic staff reviewed the participant's medical chart and her chosen contraceptive method, reconfirmed the inclusion criteria, and relayed results to the research team."	■ A total of 62 participants were randomized and included in the intent-to-treat analysis	■	■
Halpern et al. (2008)	■ Kenya site, quote, "...because Internet access was limited to certain higher-income neighborhoods, school recruitment and assignment of schools to ''web'' and ''comparison'' groups could not be completely random." Brazil site: "Schools were recruited on the basis of size, equitable mix of race, gender and social class, non-denominational curricula, and public funding."	■ Non-random assignment	■ Unclear if participants or research team blinded	■ No evidence of blinding, though outcome measurement unlikely to be influenced due to use of self-administered questionnaires	■ Kenya site: 1530 students completed module 1, with 1178 students completing modules 1 and 6 with complete information for gender and age (799 in the intervention group and 379 in the control group). Quote, "Loss to follow-up was similar in web and comparison groups", though unclear how many students were initially allocated to each study arm. Brazil site: 1412 students completed module 1, with 714 students completing modules 1 and 6 with complete information for gender and age (559 in the intervention group and 155 in the control group).	■	■ Non-randomized study

there was no significant difference in the proportion of implant insertions at 3-month follow-up between those assigned to an educational DVD about a contraceptive implant versus those receiving information from a healthcare provider [22]. Women in the intervention group were also given the opportunity to discuss questions with a healthcare provider after viewing the video.

3.8. Contraception use: nonrandomized comparison studies

One multisite study at family planning clinics in the US evaluated oral contraceptive adoption at 1-year follow-up among adolescent women expressing an intention to use oral contraceptives [26]. At the Chicago site, participants who used a computerized contraceptive decision aid in addition to standard patient education were more likely to adopt oral contraceptives compared to those receiving standard patient education only ($p=.05$). At the Madison site, no significant difference in oral contraceptive adoption between groups was detected. Among women using oral contraceptives, there was no statistically significant difference in total months of use between groups.

3.9. Pregnancy: RCTs

Three RCTs assessed the frequency of pregnancy [24,29,33,34]. In an evaluation of an interactive computer program administered on waiting

Table 4 (*continued*)

					Quote, "Loss to follow-up was similar in web and comparison groups", though unclear how many students were initially allocated to each study arm		
Hersh et al. (2018)	■	■	■ Participants and study personnel not blinded	■ Outcome assessment not blinded, though outcome measurement unlikely to be influenced due to use of self-administered questionnaires	■ A total of 240 participants randomized and 239 analyzed	■	■ Participants were women admitted to a hospital for childbirth. Participants were excluded if they reported a pain level higher than 8 on the Wong-Baker FACES pain scale. Labor and associated pain could have influenced contraceptive method choice in both study groups
Ingersoll et al. (2018)	■	■	■ Unclear if participants or study personnel blinded to intervention allocation	■ No evidence of blinding; potential to impact outcome assessment during review of diaries. Unclear if standardized questionnaire used for phone interviews	■ A total of 75 participants randomized with 64 analyzed at 6 months follow-up: 33 in the intervention group and 31 in the control group	■	■
Mason et al. (2003)	■	■	■ Participants not blinded. Clinicians blinded to intervention allocation. Research team not blinded	■ No blinding, though researchers used a standardized questionnaire for interviews	■ A total of 31 participants (from two locations) randomized and analyzed: 15 in the intervention group and 16 in the control group	■	■
Michie et al. (2016)	■	■	■ Participants and personnel not blinded	■ No blinding, though method choice evaluated using a standardized interview format	■ A total of 50 participants randomized (35 to the intervention group and 15 to the control group) with all 50 included in analysis of information recall immediately post-intervention. At 3 months follow-up, 38 participants were included in the analysis of method choice: 27	■	■

room kiosks in acute care settings in the US, women in the intervention group received information about contraceptives and could also request a prescription for a contraceptive [24]. Women in the control group received information about screening for chlamydia. At 3-month follow-up, a smaller proportion of participants in the intervention group had unintended pregnancies (0.9%) compared to the control group (3.8%), though this difference was not statistically significant. A TTM-based intervention focused on increasing dual-method uptake and adherence among women in the US found no significant difference in rates of unintended pregnancy between intervention and control groups at 24-month

Table 4 (*continued*)

					(77%) in the intervention group and 11 (73%) in the control group		
Peipert et al. (2008)	■	■	■ Unclear if participants blinded. Regarding the research team, quote: "Although true masking was difficult in this setting, every effort was made to mask the follow-up evaluators to the treatment allocation."	■ Incomplete blinding of research team likely. Unclear if standardized questionnaires used for phone or in-person surveys	■ A total of 542 participants randomized: 272 to the intervention group and 270 to the control group. 346 participants completed the 24-month follow-up: 166 in the intervention group (61%) and 180 in the control group (67%). Reasons for attrition included withdrawn, lost to follow-up, or no outcome info	■	■ Unclear if some participants may have completed scheduled surveys at later time points: quote, "At 12 and 24 months after baseline, participants were asked to return for follow-up examinations and completion of follow-up and background surveys." The authors also report that 346 participants completed the 24 month follow-up, though tables displaying outcome data at 24 months show 542 participants (Peipert et al. 2008)
Schwarz et al. (2013)	■	■	■ Unclear if participants or research team blinded	■ No evidence of blinding. Unclear if standardized questionnaire used for phone survey	■ A total of 814 participants were randomized: 415 to the intervention group and 399 to the control group. In the intervention group, 125 participants were excluded after further eligibility screening and 76 left the kiosk prior to using the module, leaving 214 eligible participants who used the module. In the control group, 98 participants left the kiosk prior to using the module leaving 301 participants who used the module. At the 3 month assessment, 97 participants in the intervention group (45%) and 146 participants in the control group (49%) were lost to follow up. An additional 74 participants in the control group were excluded at this time after further eligibility	■	■ Participants could complete the follow-up survey by phone or email. Unclear if responses differed by mode or mode differed by treatment group

Table 4 (*continued*)

					screening. Ultimately, 198 participants were included in the final analyses: 117 in the intervention group and 81 in the control group		
Sridhar et al. (2015)	■	■	■ Unclear if participants or research team blinded	■ No evidence of blinding, though outcome measurement unlikely to be influenced; knowledge evaluated using a standardized self-administered questionnaire and method choice verified through review of medical records	■ A total of 120 participants were randomized: 60 to each group. All 120 participants were included in the analysis of method choice. Knowledge of very effective contraceptive methods was evaluated among the 65 participants who selected a very effective method: 31 in the intervention group and 34 in the control group	■	■
Stephenson et al. (2011)	■ Randomization procedure not described	■ Allocation process not described	■ Unclear if participants or research team blinded	■ No evidence of blinding. Unable to determine if measurement of method choice likely to be influenced: unclear how patient method choice determined (Stephenson et al. 2011). Measurement of pregnancy outcome clinically determined and unlikely to be influenced (described in Wall, Vwalika et al. 2013)	■ A total of 1502 couples were randomized. After limiting the population of interest to couples with at least one living child and who initiated a method of contraception after the intervention, 957 couples were analyzed (Stephenson et al. 2011). After limiting the population of interest to OCP users, 513 women were analyzed (Wall, Haddad et al. 2013). After exclusion of couples with no follow-up visits, those with no living children, or couples in which the man desired more children, 1060 couples were analyzed (Wall, Vwalika et al. 2013), leaving 71% of the participants allocated to the non-methods video group and 70% of the participants allocated to the methods video group.	■	■

follow-up (HR=1.22, 95% CI 0.73–2.04) [29]. However, the authors noted limited power to detect effects of interest due to increased use of condoms in the control arm. In an evaluation of methods and motivational-based videos focusing on LARC promotion among HIV serodiscordant and concordant heterosexual couples in Zambia, time to unintended pregnancy among oral contraceptive pill (OCP) users did not significantly differ between those viewing the intervention videos and those viewing a control video [33]. However, among couples in which the woman was already using a contraceptive method at enrollment, at any time during the study having viewed the methods-based video was associated with a lower rate of pregnancy compared to those who viewed the motivational or control videos (HR=0.38; 95% CI: 0.19–0.75) [34].

3.10. Pregnancy: nonrandomized comparison studies

For a computer-based contraceptive decision aid evaluated among adolescent women attending family planning clinics in the US, fewer pregnancies were reported at both sites at 1-year follow-up among participants receiving the intervention compared to those receiving standard patient education only [26]. While these differences were not statistically significant, the study authors noted limited power to detect this effect of interest.

4. Discussion

Eight of 13 studies reported any statistically significant intervention effects: four were video based [21,22,31,34,36] and four were interactive applications [24–26,29]. All four video-based studies were RCTs and reported significant differences between intervention groups on outcomes of knowledge, method choice or pregnancy. Of the four computer-based studies reporting significant effects, two were RCTs and two were nonrandomized comparison studies. Significant differences between study arms were reported for outcomes of contraceptive knowledge, attitudes or use. While most differences favored the intervention, effects were limited with respect to clinical relevance and the number of outcomes impacted. Importantly, 4 of the 13 studies included in this review were pilot studies [21,22,28,35], and 4 additional studies described power limitations related to outcomes of interest [24,26,27,29], highlighting the need for more robust follow-up studies.

In most cases, significant effects were reported among studies that measured outcomes immediately postintervention, which were primarily evaluations of contraceptive knowledge or method choice following video-based interventions. One nonrandomized comparison study and five RCTs completed long-term measures of outcomes (at least 3 months following the intervention). Among the RCTs, two showed statistically significant effects: a video intervention with follow-up visits at 3-month intervals that led to reduced pregnancy incidence [34] and a multimedia computer-based intervention with tailored feedback over an 80-day period that led to increased initiation of dual-method contraception [29]. A pilot study of a multimedia computer-based intervention with tailored feedback elements that was administered in a series of six modules found a marginally significant effect on episodes of unprotected sex [35]. The other two RCTs that collected long-term outcome measures but did not find statistically significant intervention effects were both administered only once and with no included follow-up visits with a healthcare provider [22,24]. This suggests that sustained effects of contraception-based interventions may be supported by elements such as the frequency of intervention administration or structured follow-up with a healthcare provider.

Receipt of tailored feedback may also be important [37]. In addition to the aforementioned RCTs incorporating tailored feedback elements within computer-based interventions showing promising long-term effects for an outcome of interest, a nonrandomized comparison study of web-based modules on reproductive health reported a strong intervention effect related to knowledge of the EC effectiveness window; the authors largely attributed this effect to an experimental feature within the modules which provided the correct response to half of intervention students answering the question item incorrectly [25]. An additional point of consideration is the frequency of the intervention: for the five-module series, one module was administered every 6–8 weeks.

Increased frequency of the intervention and receipt of tailored feedback appear to be common elements of interventions showing positive effects for long-term outcome measures. However, our ability to draw strong conclusions regarding the efficacy of specific elements is limited by the number of available studies, in addition to many of the included studies lacking adequate power to detect effects. More robust studies are needed to better evaluate mechanisms of effectiveness across outcomes of interest. Additional evaluations may also support more specific assessments of efficacy stratified by setting and population.

Electronic platforms provide diverse opportunities for the dissemination of contraceptive education, though technologies should be designed in concert with evaluations of content based on health education and behavior theories [38]. For example, in a study of three video interventions (methods based, motivational and combination), receiving the methods-focused content was associated with statistically significant effects related to outcomes of method choice and incident pregnancy [31,34]. Additionally, given that several electronic interventions performed similarly to direct counseling methods when followed by the opportunity to speak with a healthcare provider, the use of electronic media to deliver effective contraceptive education could have important implications related to lowering burdens on staff time. Interventions administered prior to seeing a healthcare provider could provide an opportunity for patients to review key information frequently addressed during the visit. Future evaluations of electronic interventions should include data on staff time involved in delivering the intervention or other measures of staff burden.

Published assessments evaluating the efficacy of electronic interventions related to contraception-based outcomes of knowledge, attitudes or practices are limited. Formal evaluations of existing tools for contraceptive education are needed to guide the development of new interventions. In designing electronic tools, the inclusion of mechanisms for tailored feedback as well as the frequency of delivery should be considered.

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References

[1] Bearak J, Popinchalk A, Alkema L, Sedgh G. Global, regional, and subregional trends in unintended pregnancy and its outcomes from 1990 to 2014: estimates from a Bayesian hierarchical model. Lancet Glob Health 2018;6:e380–9. https://doi.org/10.1016/S2214-109X(18)30029-9.
[2] Ali SA, Qidwai W, Tikmani SS. Prevalence and determinants of unintended pregnancy: systematic review. World Fam Med J Middle East J Fam Med 2016;14:37–46. https://doi.org/10.5742/MEWFM.2016.92806.
[3] Kassa N, Berhane Y, Worku A. Predictors of unintended pregnancy in Kersa, Eastern Ethiopia, 2010. Reprod Health 2012;9. https://doi.org/10.1186/1742-4755-9-1.
[4] Oulman E, Kim THM, Yunis K, Tamim H. Prevalence and predictors of unintended pregnancy among women: an analysis of the Canadian Maternity Experiences Survey. BMC Pregnancy Childbirth 2015;15. https://doi.org/10.1186/s12884-015-0663-4.
[5] Mbelle N, Mabaso M, Setswe G, Sifunda S. Predictors of unplanned pregnancies among female students at South African technical and vocational education and training colleges: findings from the 2014 Higher Education and Training HIV and AIDS survey. S Afr Med J 2018;108:511. https://doi.org/10.7196/SAMJ.2018.v108i6.12744.
[6] Chernick LS, Schnall R, Higgins T, Stockwell MS, Castaño PM, Santelli J, et al. Barriers to and enablers of contraceptive use among adolescent females and their interest in an emergency department based intervention. Contraception 2015;91:217–25. https://doi.org/10.1016/j.contraception.2014.12.003.
[7] Dixon SC, Herbert DL, Loxton D, Lucke JC. 'As many options as there are, there are just not enough for me': contraceptive use and barriers to access among Australian women. Eur J Contracept Reprod Health Care 2014;19:340–51. https://doi.org/10.3109/13625187.2014.919380.

[8] Muanda M, Gahungu Ndongo P, Taub LD, Bertrand JT. Barriers to modern contraceptive use in Kinshasa, DRC. PLoS One 2016;11:e0167560. https://doi.org/10.1371/journal.pone.0167560.
[9] Eisenberg DL, Secura GM, Madden TE, Allsworth JE, Zhao Q, Peipert JF. Knowledge of contraceptive effectiveness. Am J Obstet Gynecol 2012;206:479.e1–9. https://doi.org/10.1016/j.ajog.2012.04.012.
[10] Frost JJ, Lindberg LD, Finer LB. Young Adults' contraceptive knowledge, norms and attitudes: associations with risk of unintended pregnancy. Perspect Sex Reprod Health 2012;44:107–16. https://doi.org/10.1363/4410712.
[11] Hladky KJ, Allsworth JE, Madden T, Secura GM, Peipert JF. Women's knowledge about intrauterine contraception. Obstet Gynecol 2011;117:48–54. https://doi.org/10.1097/AOG.0b013e318202b4c9.
[12] Venkat P, Masch R, Ng E, Cremer M, Richman S, Arslan A. Knowledge and beliefs about contraception in urban Latina women. J Community Health 2008;33:357–62. https://doi.org/10.1007/s10900-008-9100-1.
[13] Oringanje C, Meremikwu MM, Eko H, Esu E, Meremikwu A, Ehiri JE. Interventions for preventing unintended pregnancies among adolescents. Cochrane Database Syst Rev 2016. https://doi.org/10.1002/14651858.CD005215.pub3.
[14] Pazol K, Zapata LB, Tregear SJ, Mautone-Smith N, Gavin LE. Impact of contraceptive education on contraceptive knowledge and decision making. Am J Prev Med 2015;49:S46–56. https://doi.org/10.1016/j.amepre.2015.03.031.
[15] Rodriguez J, Abutouk M, Roque K, Sridhar A. Personalized contraceptive counseling: helping women make the right choice. Open Access J Contracept 2016:89. https://doi.org/10.2147/OAJC.S81546.
[16] McHenry MS, Fischer LJ, Chun Y, Vreeman RC. A systematic review of portable electronic technology for health education in resource-limited settings. Glob Health Promot 2017:175797591771503. https://doi.org/10.1177/1757975917715035.
[17] Timmons SE, Shakibnia EB, Gold MA, Garbers S. MyLARC: a theory-based interactive smartphone app to support adolescents' use of long-acting reversible contraception. J Pediatr Adolesc Gynecol 2018;31:285–90. https://doi.org/10.1016/j.jpag.2017.11.005.
[18] Akinola M, Hebert LE, Hill BJ, Quinn M, Holl JL, Whitaker AK, et al. Development of a mobile app on contraceptive options for young African American and Latina women. Health Educ Behav 2019;46(1):89–96. https://doi.org/10.1177/1090198118775476.
[19] Wilson EK, Krieger KE, Koo HP, Minnis AM, Treiman K. Feasibility and acceptability of a computer-based tool to improve contraceptive counseling. Contraception 2014;90:72–8. https://doi.org/10.1016/j.contraception.2014.02.027.
[20] Higgins J, Green S. Cochrane handbook for systematic reviews of interventions. 5.1.0. The Cochrane collaboration; 2011.
[21] Mason V, McEwan A, Walker D, Barrett S, James D. The use of video information in obtaining consent for female sterilisation: a randomised study. Br J Obstet Gynaecol 2003:10.
[22] Michie L, Cameron ST, Glasier A, Johnstone A. Giving information about the contraceptive implant using a DVD: is it acceptable and informative? A pilot randomised study. J Fam Plann Reprod Health Care 2016;42:194–200. https://doi.org/10.1136/jfprhc-2015-101186.
[23] Swartz LHG, Sherman CA, Harvey SM, Blanchard J, Vawter F, Gau J. Midlife women online: evaluation of an internet-based program to prevent unintended pregnancy & STIs. J Women Aging 2011;23:342–59. https://doi.org/10.1080/08952841.2011.613255.
[24] Schwarz EB, Burch EJ, Parisi SM, Tebb KP, Grossman D, Mehrotra A, et al. Computer-assisted provision of hormonal contraception in acute care settings. Contraception 2013;87:242–50. https://doi.org/10.1016/j.contraception.2012.07.003.
[25] Halpern CT, Mitchell EMH, Farhat T, Bardsley P. Effectiveness of web-based education on Kenyan and Brazilian adolescents' knowledge about HIV/AIDS, abortion law, and emergency contraception: findings from TeenWeb. Soc Sci Med 2008;67:628–37. https://doi.org/10.1016/j.socscimed.2008.05.001.
[26] Chewning B, Mosena P, Wilson D, Erdman H, Potthoff S, Murphy A, et al. Evaluation of a computerized contraceptive decision aid for adolescent patients. Patient Educ Couns 1999;38:227–39. https://doi.org/10.1016/S0738-3991(99)00014-2.
[27] Davidson AS, Whitaker AK, Martins SL, Hill B, Kuhn C, Hagbom-Ma C, et al. Impact of a theory-based video on initiation of long-acting reversible contraception after abortion. Am J Obstet Gynecol 2015;212:310.e1–7. https://doi.org/10.1016/j.ajog.2014.09.027.
[28] Gilliam ML, Martins SL, Bartlett E, Mistretta SQ, Holl JL. Development and testing of an iOS waiting room "app" for contraceptive counseling in a Title X family planning clinic. Am J Obstet Gynecol 2014;211:481.e1–8. https://doi.org/10.1016/j.ajog.2014.05.034.
[29] Peipert JF, Redding CA, Blume JD, Allsworth JE, Matteson KA, Lozowski F, et al. Tailored intervention to increase dual-contraceptive method use: a randomized trial to reduce unintended pregnancies and sexually transmitted infections. Am J Obstet Gynecol 2008;198:630.e1–8. https://doi.org/10.1016/j.ajog.2008.01.038.
[30] Peipert JF, Zhao Q, Meints L, Peipert BJ, Redding CA, Allsworth JE. Adherence to dual-method contraceptive use. Contraception 2011;84:252–8. https://doi.org/10.1016/j.contraception.2011.01.023.
[31] Stephenson R, Vwalika B, Greenberg L, Ahmed Y, Vwalika C, Chomba E, et al. A randomized controlled trial to promote long-term contraceptive use among HIV-serodiscordant and concordant positive couples in Zambia. J Women's Health 2011;20:567–74. https://doi.org/10.1089/jwh.2010.2113.
[32] Sridhar A, Chen A, Forbes ER, Glik D. Mobile application for information on reversible contraception: a randomized controlled trial. Am J Obstet Gynecol 2015;212:774.e1–7. https://doi.org/10.1016/j.ajog.2015.01.011.
[33] Wall KM, Haddad L, Vwalika B, Htee Khu N, Brill I, Kilembe W, et al. Unintended pregnancy among HIV positive couples receiving integrated HIV counseling, testing, and family planning services in Zambia. PLoS One 2013;8:e75353. https://doi.org/10.1371/journal.pone.0075353.
[34] Wall KM, Vwalika B, Haddad L, Khu NH, Vwalika C, Kilembe W, et al. Impact of long-term contraceptive promotion on incident pregnancy: a randomized controlled trial among HIV-positive couples in Lusaka, Zambia. J Acquir Immune Defic Syndr 2013;63:86–95. https://doi.org/10.1097/QAI.0b013e31827ee19c.
[35] Ingersoll K, Frederick C, MacDonnell K, Ritterband L, Lord H, Jones B, et al. A pilot RCT of an internet intervention to reduce the risk of alcohol-exposed pregnancy. Alcohol Clin Exp Res 2018;42:1132–44. https://doi.org/10.1111/acer.13635.
[36] Hersh AR, Muñoz LF, Rincón M, Alvarez C, Tolosa JE, Moreno DJ, et al. Video compared to conversational contraceptive counseling during labor and maternity hospitalization in Colombia: a randomized trial. Contraception 2018;98:210–4. https://doi.org/10.1016/j.contraception.2018.05.004.
[37] Garbers S, Meserve A, Kottke M, Hatcher R, Chiasson MA. Tailored health messaging improves contraceptive continuation and adherence: results from a randomized controlled trial. Contraception 2012;86:536–42. https://doi.org/10.1016/j.contraception.2012.02.005.
[38] Lopez LM, Tolley EE, Grimes DA, Chen M, Stockton LL. Theory-based interventions for contraception. The Cochrane collaboration. Cochrane Database Syst. RevChichester, UK: John Wiley & Sons, Ltd; 2013. https://doi.org/10.1002/14651858.CD007249.pub4.