Review Article

A systematic review of eHealth modes in preventing sexually transmitted infections

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Abstract

Prevention of sexually transmitted diseases (STDs) is critical. Despite developing treatment and prevention programs, sexually transmitted infections (STIs) are essential in developing acute and chronic diseases. Because "eHealth" (electronic-Health) has excellent potential for disseminating health information to the public regarding STDs, we aimed to identify and review all published articles focusing on preventing STIs. After constructing the design and answering population, intervention, comparison, and outcome questions, two authors conducted a systematic literature search in four online databases in January 2022. The screening process and data extraction were conducted by two authors independently, and then, a quality assessment was performed. After removing duplicates, and two rounds of shortlisting, 16 articles were included for data extraction out of 5113 entries. Included studies were of different designs and assessed six preventive outcomes categories, with condom use being the most frequent result among studies. We also extracted implementation outcomes and reviewed them. Included studies with 13,137 participants have provided reasonable evidence of the effectiveness of different types of eHealth in improving STI prevention interventions. Although this systematic review was not without limitations, it can no longer be ignored that eHealth modes offer many opportunities to prevent STDs, especially among the young population.

Key words: EHealth, mHealth, sexually transmitted infections, sexually transmitted diseases, sexually transmitted infections

Introduction

infectious agents are the most important cause of health problems in couples. More than 30 different bacteria, viruses, and parasites are transmitted through sexual contact.[1] Estimations suggest that among persons aged 15–49 years, there is an annual rate of about 357 million new curable cases of sexually transmitted infections (STIs) worldwide. The rate is similar for viral infections, with an estimated 417 million people infected.[2] The estimated number of new cases of sexually transmitted diseases (STDs) in a day is about 1 million worldwide. Control of STDs and education are critical.[3-5] STDs are caused by microorganisms found in the male and female genitalia. They can often be asymptomatic or have mild symptoms not recognized as STIs. Despite developing antibiotics, vaccines, and disease prevention and control programs, STIs are an essential factor in developing acute and chronic diseases.[6] Immediate health education interventions are needed to curb the spread of STDs. Educating people about strategies for infection prevention is now a successful way against these diseases.[7]

Education, learning, and behavior patterns change and evolve over time. The development of science and technology and the accompanying dramatic changes in various fields posed significant challenges to our ancestors. The fact that it was so easy to use tools instead of human resources caused scholars to think about using technology in education and learning. This led to educational packages and learning with electronic tools, later known as virtual education. Recent studies show that it is better to design educational materials with virtual education methods to learn the material with motivation and interest to achieve

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the educational methods that most people are satisfied with and interested in.[8]

With technological advances and the medical community's increasing access to new information through various means such as computers, cell phones, the Internet, and virtual networks, the need for various distance education and self-learning methods is becoming more apparent.[9-11]

E-learning is the most advanced technology-based learning method offered through CD, LAN (local area network), or the Internet. It includes computer-assisted learning and web-based learning[12,13] and offers everyone the opportunity to learn in any subject.[14]

Although traditional face-to-face learning is currently the most prevalent education system, e-learning can be ubiquitous and provide an education system with higher quality and well-designed instructional materials if it transcends geographic boundaries.[15]

As a result of the development of the Internet and mobile education in recent years, the market for health-related applications has developed rapidly, increasing the potential of this sector.[16] Several health-related applications have been developed for smartphones, tablets, and other mobile devices, offering games and services according to individual location and access to social networks and health care.[17] Thus, "programs" have great potential for disseminating health information to the public, especially for patients with taboo diseases such as STDs and for people with taboo conditions such as homosexuals[18]–approximately 332 million Internet users in Latin American countries, including 114 million Brazilians. The app most used by Brazilians is WhatsApp, with 46 million users. In addition, two of the largest distribution platforms for the app, the App Store and Google Play, are currently active. As a result of this growth, researchers have sought to closely evaluate the methodological and scientific aspects of the programs to ensure that their components can effectively change behavior and be as effective as possible in controlling STIs. However, conducting research using mHealth is a complex intervention process that incorporates information and communications technology-specific (ICT) features throughout the project. Given the importance of mobile technology and the use of this tool by a large number of people around the world, as well as the importance of studies on the prevention, diagnosis, treatment, and control of STIs, this article aimed to identify and evaluate all published articles with a focus on their quality, and with the purpose of summarizing and comparing their conclusions, so that the best evidence is available for decision-makers.

Methods

the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA)[19] constructed the basis for all steps of this systematic review; therefore, these guidelines were followed throughout the process [Figure 1].

Population, intervention, comparison, and outcome questions

the following question population, intervention, comparison, and outcome was formulated before the systematic search: "Were mHealth (mobile-Health) methods effective in preventing STIs compared with other commonly used prevention interventions?" Accordingly, the "population" was people at risk for STIs (people of sexually active age) receiving mHealth services. Different types of mHealth modalities were defined as "intervention." The "comparison groups" were control groups that received other preventive measures. Because we included studies without control groups, there may be no comparisons for cohorts and cross-sectional studies. Hence, all studies reporting on mHealth for the prevention of STIs had the chance to be included. According to PICO, the "outcome" was the measure of STI prevention.

Search strategy

two authors (Firoozeh Nourimand and Afsaneh Keramat) conducted a systematic literature search in Web of Science (Clarivate interface), Medline (PubMed interface), Elsevier's abstract, and citation database (Scopus interface), and Cochrane (Wiley interface) in January 2022 using the following search terms: STDs/transmission, per act, per sexual act, per coitus, per partner, per couple, STD, Mycoplasma infections, Mycoplasma genitalium, Chlamydia, Human herpesvirus 2, Lymphogranuloma venereum, Neisseria gonorrhoeae, Pelvic inflammatory disease (PID), Syphilis, Trichomonas, Urethritis, Uterine cervicitis, Bacterial vaginosis, cervicitis, mycoplasma, genitalium, chlamydia, genital ulcer, genital ulcer disease, genital ulcer, herpes, herpesvirus, HSV, HSV2, HSV-2, gonorrhea, gonorrhea, PID, PID, syphilis, Treponema Pallidum, Trichomonas, Trichomoniasis, Urethritis, Vaginosis, sexually transmitted, STD, STDs, STI, STIs, genital infections*, Syphilis, Syphilitic, Treponema Pallidum; For STDs.

The following keywords were searched for mHealth: mHealth, handheld computer, smartphone, mobile technology, mobile device, cell phone, mobile app, text message, SMS, mobile health, mobile application*, mobile health application*, mHealth, cell phone, smartphone, telemedicine, telecommunications, telephone, remote consultation, information technology, eHealth, internet, web-based, social media, application, software *.

We manually searched the reference list of included studies to identify potentially relevant studies.

Eligibility criteria

Randomized controlled trials (RCTs), case–controlled trials, and cohort studies were included in this systematic review; case reports and review articles without original data were excluded from our systematic review.

We included articles that:

1. Examined attitudes toward STI/HIV prevention, sexual negotiability, and refusal attitudes
2. Reported outcomes on STI incidence, test adherence, and knowledge of STI control;
3. Reported condom use and STI testing;
4. Examined risky sexual behaviors; and
5. Examined intention to practice safer sex behaviors.

Our screening team excluded an article if it was:

1. A case report, case series, nonoriginal research, secondary report, commentary, editorial, review, or duplicate
2. Studies did not report outcomes related to STI prevention
3. Studies reported outcomes related to only one specific STDs.

Screening and data collection

All search results were imported into EndNote 20 (Clarivate Analytics) to screen title, abstract, and full text. Two reviewers selected studies in two separate rounds (Firoozeh Nourimand and Afsaneh Keramat). After screening, the data extracted independently by two

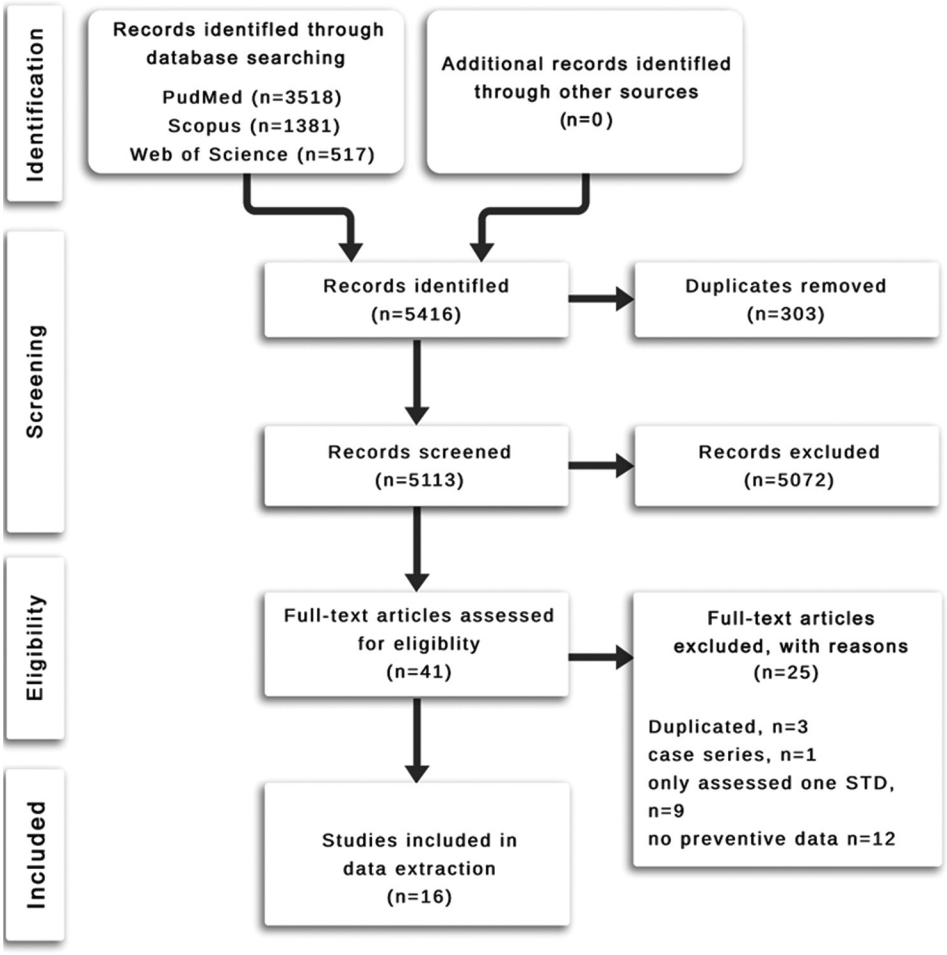

Figure 1: PRISMA flow diagram. PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyzes

reviewers (Firoozeh Nourimand and Afsaneh Keramat) were imported into an online Google spreadsheet in a standardized order: First author name, year of publication, year of study, country or region of study, design, sample size, study population characteristics, settings, preventive outcomes, and assessment instruments. The overall agreement rate among reviewers was 95%, and all discrepancies and disagreements were discussed and resolved by reviewing the inclusion or exclusion criteria and reaching a consensus. Finally, the entire process was validated by another staff member (Leila Bozorgian).

Quality assessment

Two independent authors (Firoozeh Nourimand and Afsaneh Keramat) performed the methodological quality (risk of bias) assessment based on the available quality assessment tools developed by National Heart, Lung and Blood Institute (NHLBI) (14-item checklist for Quality Assessment of Controlled Intervention Studies and 14-item checklist for Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies). Both authors were trained in the use of study-rating instruments. We scored articles with "no" or "cannot determine" or "not applicable" or "not reported" answers zero, whereas a "yes" answer for each question of risk of bias scored 1. Then, we categorized articles as "good" (low risk of bias), "fair" (some risk of bias), or "poor" (significant for risk of bias).

Results

According to the above inclusion and exclusion criteria, the systematic electronic literature search yielded 5113 entries. After removing duplicates, 4810 records were included in the title and abstract screening. Of these, 19 records were eligible for full-text screening for this systematic review. Ultimately, we considered 16 articles with 13,137 participants based on the inclusion criteria. Figure 1 shows the PRISMA flow diagram illustrating the systematic process used to conduct the review.

Characteristics of the included studies

Six studies were randomized control trials (RCTs),[20-25] three studies had a quasi-experimental design,[26-28] three cross-sectional studies were included,[29-31s] one pilot study,[32s] one cohort study,[33s] one protocol for RTC,[34s] and one design article[35s] among the included datasets. Eight articles with 9840 participants used mobile-based services[24-26,29-31s, 34s, 35s] seven articles provided Internet- or Web-based services to 4007 people[21-23,27,28,32s, 33s] and one article evaluated a telephone-based intervention for 701 people.[20] Included studies were published between 2011 and 2021 and conducted in the United States (n = 6),[20,22,24,25,27,32s] China (n = 2),[33s, 34s] Korea,[26] Ghana,[29] Chile,[28], Spain,[30] Australia,[21] the United Kingdom,[23] and Germany[31s] (one each) Table 1.

Table 1: Characteristics of included studies

First author	Study year	Publication year	Design	Target population	Setting	Population size	main eHealth modes	Gender	Age	Follow-up period	Methods/ assessments	Outcomes	Implementation outcomes
R. J. DiClemente	2005-2007	2014	RCT	African American Adolescents	US	701	Telephone contact	Female	Combined=17.64 (1.67) Experimental=17.55 (1.62) Comparison=17.73 (1.72)	36 months	STI/ HIV-preventive attitudes, sexual negotiation and refusal skills, safer sex norms, and proportion of condom-protected sexual acts	Participants in the experimental condition reported a higher proportion of condom use in the 90 days and 6 months prior to assessments and fewer episodes of sexual acts while high on drugs and/or alcohol	Feasibility Acceptability Appropriateness
X. Yan	2020-2022	2020	Protocol	MSM	China	6172	Mobile services	Male	N/A	6 months	STIs testing adherence, knowledge of STDs control, and changes of high risk behaviors	N/A	Cost
R. K. Alhassan	2016	2019	CS	People aged 18-24	Ghana	250	Mobile phones	Female=101 Male=149	N/A	N/A	Knowledge on STI control	Most of the participants believe that mobile applications were the most appropriate means for STIs education.	Acceptability Adoption
L. Widman	2015	2017	PP	10th-grade girls	US	371	Web-based	Female	15.26 (0.48)	N/A	Safer sex motivation, STD knowledge, sexual norms/ attitudes, safer sex self-efficacy and sexual communication skills	new online program is a promising method to reach and engage adolescents in STD education and prevention	Acceptability Feasibility
N. J Mortimer	2013	2015	RCT	Adults aged 18-29 years	Australia	375	Web-based	Female=87 (intervention) 151 (control) Male=63 (intervention) 93 (control)	Intervention=21.8 (2.9) Control=21.3 (2.8)	1 month	Sexual activity, number of sexual partners, condom use, previous STI testing, and previous infection	Healthy.me PCHMS was associated with a significantly greater proportion of participants engaging in healthy sexual behaviors	N/A
F. Besoain	2014	2015	Design	MSM	International	17	Prototype software	Male	21-60	N/A	Condom use	N/A	N/A

Contd...

Table 1: Contd...

First author	Study year	Publication year	Design	Target population	Setting	Population size	main eHealth modes	Gender	Age	Follow-up period	Methods/ assessments	Outcomes	Implementation outcomes
M. A. Gutiérrez	2015-2016	2018	CS	MSM	Spain	2656	App	Male	>18	N/A	High risk sexual behaviors	strategy was useful tool for the prevention and for promoting rapid STI tests in the MSM	Acceptability Effectiveness Feasibility
C. K. Danielson	2011-2012	2013	Trial	African American adolescents	US	41	Web-based	Female	15.85 (1.42)	3 months	Knowledge on STI control, condom use, and risky sexual behaviors	SiHLEWeb increased knowledge on STI risks and condom use self-efficacy, and risk reduction behavior	Feasibility
N.Villegas	2011	2014	PP	18-24 years women	Chile	40	Web-based	Female	19.90 (1.99)	1 month	Risky sexual behaviors	The intervention reduced barriers to accessing preventive interventions and increase STI prevention	Acceptability Feasibility
P. F. Weitzman	2017	2019	RCT	Divorced/ separated women	US	219	Web-based	Female	54.6 (3.6)	N/A	Questionnaire to assess intention to engage in safe sex behaviors	Intervention group reported greater intention to practice safe sex	N/A
L. Jakob	2019	2020	CS	German-speaking adults	Germany	226	App	Female=49 Male=161	40.2 (15.2)	N/A	N/A	Nearly half of the patients considered STD apps useful	N/A
E. Wilson	2017	2019	RCT	People aged 16-30 years	UK	528	Web-based	Female=130 (intervention) 142 (control) Male=113 (intervention) 141 (control)	Intervention=21.3 (3.5) Control=21.3 (3.6)	N/A	STI testing rate among never testers	Uptake of STI testing among 'never testers' almost doubled	Acceptability
D. Cordova	2016-2017	2020	RCT	13-21 years people	US	50	Mobile phones	Female intervention=21 Control=20 (80) Male intervention=2 (8) Control=2 (8) Transmale intervention=1 (4) Control=3 (12)	Intervention=18.6 (2.15) Control=19.0 (2.19)	1 month	Sexual risk behaviors, and STI testing	S4E participants demonstrated increases in prevention knowledge, a reduction in the proportion of condomless sex, and alcohol use before sex, and an increase in the proportion of STI testing	N/A

Contd...

Table 1: Contd...

First author	Study year	Publication year	Design	Target population	Setting	Population size	main eHealth modes	Gender	Age	Follow-up period	Methods/ assessments	Outcomes	Implementation outcomes
C. Woods	N/A	2021	RCT	16-25 years people	US	381	Dyadic	Female=285 Male=96	20.9 (2.3)	N/A	N/A	A dyadic behavioral STI intervention trial using social media is feasible	Cost Feasibility Acceptability
Y. Hong	2009	2011	Cohort	Female sex workers	China	1022	Web-based	Female	24.9 (6.7)	N/A	Attitude toward STI prevention	Willingness to participate in an online STI prevention intervention was significantly associated with higher Internet use and younger age	N/A
S. Jeong	2016	2017	QE	13 years students	Korea	88	App	Female intervention=26 Control=16 Male intervention=21 Control=25	N/A	N/A	STI knowledge, STI vulnerability, STI prevention self-efficacy and STI prevention intentions	Significant group differences were found at different times in STI knowledge, vulnerability, prevention self-efficacy, and prevention intentions	N/A

RCT=Randomized controlled trial, N/A=Not available, STIs=Sexually transmitted infections, HIV=Human immunodeficiency virus

Quality assessment

Based on the NHLBI quality assessment tool for observational cohort and cross-sectional, we detected all included cross-sectional studies rated as "good" for risk of bias. Except for three randomized control trials, which were rated as "good,"[20,23,27] the rest were scored as "fair" for risk of bias, according to the NHLBI instrument for quality assessment of controlled intervention studies. None of the included studies was rated as "poor" as shown in Tables 2 and 3.

Indicators of sexually transmitted infections prevention

The degree of heterogeneity in reporting subjective or objective indicators of STI prevention was significant. We included studies that reported at least one of the following six indicators: attitude toward STI prevention, knowledge of STI control, condom use, STI testing rate, intention to practice safer sex, and rate of risky sexual behaviors. Eight studies (50.0%) reported at least two indicators of STI prevention. The most common outcomes were related to condom-protected sex (n = 7, 43.8%), knowledge of STI control (n = 6, 37.5%), and the rate of risky sexual behaviors (n = 6, 37.5%).

Attitude toward sexually transmitted infections prevention

The work of Widman *et al*.,[27] Jakob *et al*.,[31s] and Hong *et al*.[33s] examined attitudes toward STI prevention. While Widman reported a 95% acceptability rate for a web-based HIV/STD prevention program for adolescent girls, nearly half of the participants in Jakob's work thought apps were valuable for STD treatment and prevention, and 47.8% agreed that STD-related apps could complement physician counseling. Hong's findings suggest that 64% of sex workers would be willing to participate in an online STI prevention program.

Knowledge about sexually transmitted infections control

The following authors' assessments showed improvements in STI prevention knowledge: Yan *et al*.,[34s] Alhassan *et al*.,[29] Widman *et al*.,[27] Danielson *et al*.,[32s] Cordova *et al*.,[24] and Jeong *et al*.[26] About two-thirds of the respondents (adolescents and young adults) in Alhassan's study were interested in using cell phones for STI education. According to Danielson, knowledge about STIs improved significantly among participants who received STD education and condom demonstration. Cordova reported higher statistically significant prevention knowledge in the intervention group. According to Jeong's findings, the experimental group's mean STI knowledge improved dramatically after the intervention and remained unchanged 5 weeks later.

The sexual act protected with a condom

DiClement *et al*.,[20] Widman *et al*.,[27] Mortimer *et al*.,[21] Danielson *et al*.,[32s] Alarcón Gutiérrez *et al*.,[30] Cordova *et al*.,[24] and Besoain *et al*.[35s] examined the proportion of condom use among their participants. Participants in the experimental group in the DiClemente study reported a statistically higher proportion of condom use in the 90 days and 6 months prior to the assessments. 60% of the girls participating in Widman's observation used condoms during their last sexual intercourse. Danielson and Cordova reported a significant decrease in condomless intercourse and increased condom use. However, in contrast to the other studies, Gutiérrez reported that 51.4% of participants had reported anal intercourse without a condom.

Intention to practice safer sex

Weitzman *et al*.[22] and Jeong *et al*.[31s] examined their participants' intention to prevent sex. The average level of STI prevention intention increased in both studies, and a significant difference was found between the experimental and control groups.

Risky sexual behaviors

Six studies examined STI prevention by focusing on risky sexual behaviors: DiClemente *et al*.,[20] Yan *et al*.,[34s] Danielson *et al*.,[32s] Villegas *et al*.,[28] Cordova *et al*.,[24] and Woods *et la*.[25] While participants in DiClemente's study engaged in fewer sexual acts while intoxicated with drugs or alcohol, Villegas' findings suggest a significant reduction in risky sexual behaviors. According to Danielson, more than a quarter of sexually active girls reported having engaged in risky sexual behavior in the past. In Cordova's study, participants reported lower alcohol consumption before sex.

Implementation outcomes

In parallel, nine articles reported the results of implementing eHealth methods to prevent STIs. Most of them reported on eHealth interventions' acceptability (n = 7)[20,23,25,27-30] and feasibility (n = 6)[20,25,27,28,30,32s] Cost (n = 2),[25,34s] appropriateness (n = 1),[20] adoption (n = 1),[29] and effectiveness (n = 1)[30] were other findings.

Discussion

The evidence presented here suggests that the eHealth interventions included in this systematic literature review have provided reasonable evidence of the effectiveness of different types of eHealth in improving STI prevention interventions. To the best of our knowledge, this is the first systematic review of the relationship between eHealth and STI prevention, comprising 16 articles with 13,137 participants.

The main primary outcomes related to STI prevention were attitudes toward STI prevention, knowledge about STI control, condom use, STI testing rates, intention to practice safer sex, and risky sexual behaviors.

Attitudes toward STIs were assessed in several articles using questions such as:

Do you think you should learn about these diseases in school?

"Would you like to know if you have already acquired a STD*?"*

"Do you think sex education should be mandatory for young people?"

"What is your opinion on sex before marriage?"

"Do you think screening for STDs is important?"

"Would you seek treatment if you noticed symptoms of STDs?"

The following questions were used to assess knowledge about STDs:

"What are the symptoms of STDs?"

"What is your knowledge of the mode of transmission for STDs?"

"Which of the diseases mentioned are STDs, and are they curable or not?"

"What is your source of information regarding STDs?"

"What are the most common complications of STDs*?"*

Respondents answered the following questions about condom use:

Table 2: Quality assessment of trials

	First author											
	Ralph J. DiClemente	X.Yan	L. Widman	N.J.Mortimer	F.Besoain	C.K.Danielson	N. Villegas	P.F. Weitzman	E. Wilson	D. Cordova	C. Woods	Sookyung J.
	Year											
	2015	2020	2017	2015	2015	2013	2014	2019	2019	2020	2020	2017
1. Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT?	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No
2. Was the method of randomization adequate (i.e., use of randomly generated assignment)?	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	No
3. Was the treatment allocation concealed (so that assignments could not be predicted)?	Yes	No	Yes	Yes	UC	N	No	Yes	No	No	No	No
4. Were study participants and providers blinded to treatment group assignment?	Yes	No	No	No	No	N	No	No	No	No	No	No
5. Were the people assessing the outcomes blinded to the participants' group assignments?	Yes	Yes	Yes	No	No	N	No	No	No	No	No	No
6. Were the groups similar at baseline on important characteristics that could affect outcomes (e.g., demographics, risk factors, co-morbid conditions)?	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Was the overall drop-out rate from the study at endpoint 20% or lower of the number allocated to treatment?	No	UC	Yes	Yes	UC	No	No	No	Yes	No	No	No
8. Was the differential drop-out rate (between treatment groups) at endpoint 15 percentage points or lower?	No	UC	No	Yes	UC	No	Yes	No	Yes	No	No	No
9. Was there high adherence to the intervention protocols for each treatment group?	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes
10. Were other interventions avoided or similar in the groups (e.g., similar background treatments)?	Yes	Yes	Yes	UC	Yes	Yes	UC	Yes	Yes	Yes	Yes	Yes
11. Were outcomes assessed using valid and reliable measures, implemented consistently across all study participants?	Yes	UC	Yes	Yes	No	No	No	No	Yes	No	No	No
12. Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power?	Yes	No	No	Yes	No	No	No	No	Yes	No	No	Yes
13. Were outcomes reported or subgroups analyzed prespecified (i.e., identified before analyses were conducted)?	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14. Were all randomized participants analyzed in the group to which they were originally assigned, i.e., did they use an intention-to-treat analysis?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Sum/14	11	5	10	9	4	7	4	8	11	6	7	5

RCT=Randomized controlled trial

Table 3: Quality assessment of cross sectional studies

	First author			
	R.K.Alhassan	M.A.Gutiérrez	L. Jakob	Y. Hong
	Years			
	2019	2018	2020	2020
Was the research question or objective in this paper clearly stated?	Yes	Yes	Yes	No
Was the study population clearly specified and defined?	Yes	Yes	Yes	Yes
Was the participation rate of eligible persons at least 50%?	Yes	No	Yes	Yes
Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	No	Yes	Yes	No
Was a sample size justification, power description, or variance and effect estimates provided?	No	No	No	No
For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	Yes	Yes	Yes	Yes
Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Yes	No	Yes	Yes
For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	No	No	No	No
Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	No	Yes	Yes
Was the exposure(s) assessed more than once over time?	No	Yes	Yes	Yes
Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	No	No	Yes
Were the outcome assessors blinded to the exposure status of participants?	Yes	No	No	No
Was loss to follow-up after baseline 20% or less?	No	No	Yes	Yes
Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	Yes	Yes	No	No
Sum/14	9	6	8	9

"Do you think condoms protect against STDs?"

"In the past 6 months, how many times have you had sex without a condom?"

"Do you use condoms during anal intercourse?"

"Do you use condoms when you use other methods of contraception?"

The way participants rated or selected statements such as the following was used to assess intention to have safer sex:

"I intend always to use condoms during vaginal intercourse with all my partners next month."

"I intend not to have oral sex in the next month."

"I intend to stop having unprotected sex with my partners."

Risky sexual behavior was assessed by answering the following questions:

"How many sexual partners do you currently have?"

"Have you ever had an unexpected sexual experience? How often?"

"Have you ever had sex with someone you did not know well? How often?"

"Have you ever had sex under the influence of substances? How often?"

In addition to the outcomes mentioned earlier reported by all included articles, nine articles that included 11366 participants reported implementation outcomes consisting of acceptability, feasibility, cost, appropriateness, adoption, and effectiveness. These results were discussed in the Results section. Acceptability is defined as the perception of those involved in implementation that a particular service is pleasant, palatable, or satisfying. Feasibility refers to how successfully innovations can be used or implemented in a particular facility or setting. The intent, initial determination, or action to attempt or use innovation or evidence-based approach is called *adoption*. Appropriateness refers to the innovation's relevance, usefulness, or compatibility with a particular practice context, provider, or customer and the innovation's perceived eligibility to solve a specific problem or concern. The economic effect of execution determines the cost. The amount of satisfaction produced by providing a service to a client is referred to as effectiveness.

Limitation

This review was not without some limitations:

1. Despite a comprehensive search strategy with no publication or language restrictions, we excluded potentially eligible articles, such as studies published in a language other than English, in nonindexed journals, or not published at all, despite searching multiple databases double-checking the search strategy and screening process
2. Because the impact of eHealth modes may differ across countries and cultures, verifying their impact may be difficult when studies are conducted in different settings. Access to technology varies across countries, and trends in technology may differ between them, affecting the outcomes of eHealth mode use
3. The studies included in this systematic review reported outcomes related to different eHealth interventions (e.g., Web-based, SMS-based, and mobile application), and evaluating these different modes together may affect the final judgments. Future studies may examine the preventive impact of a single eHealth intervention on STIs based on the results of our study
4. Factors indicating the impact of eHealth on STI prevention were not heterogeneous among included studies, although we sought to review six of the common assessments, and this carved a niche that may serve future studies to focus on ongoing studies to examine unique outcomes

5. The duration of follow-up in the experimental studies was mainly <6–3 months and only six articles reported data after follow-up
6. We included articles with different designs such as RCTs, cross-sectional studies, protocols, experimental and quasi-experimental studies, and cohorts that may influence the review process.

Recommendations

1. A more comprehensive search, including non-English articles and articles from nonindexed journals, should include more articles on the impact of eHealth modes on STI prevention
2. Our included studies mainly examined the impact of eHealth on short-term outcomes. More evidence on long-term follow-up is strongly recommended
3. Regarding the quality and heterogeneity of studies, future studies should improve quality using validated checklists to confirm addressing the essential characteristics of the study design
4. Access to technology varies by country, and technology expansion may differ by country, affecting outcomes of eHealth use. Future studies should explore the impact of eHealth in different countries and cultures.

Conclusion

The increasing advancement of technology and the popularity of the Internet, especially among young people, provide excellent opportunities to use eHealth to prevent many diseases. It can no longer be ignored that eHealth modes offer many opportunities to prevent STDs, especially among the young population who routinely use new technologies and the Internet and are vulnerable to STDs. Among all the other benefits of eHealth, our systematic review focused on the preventive use of eHealth for STIs. However, future studies are needed to review the other aspects and use of eHealth modes to promote sexual health and support vulnerable populations or conduct a meta-analysis.

Ethics statement

No ethical approval is needed. No personal information is included in this systematic review, and the results are submitted to peer-reviewed publications or conference presentations.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary files

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