Mobile Phone Interventions for Adolescent Sexual and Reproductive Health: A Systematic Review

Kelly L. L'Engle, PhD, MPH,[a] Emily R. Mangone, MSc,[b] Angela M. Parcesepe, PhD, MPH, MSW,[c] Smisha Agarwal, MPH, MBA, BDS,[b,d] Nicole B. Ippoliti, MPH[e]

abstract

CONTEXT: Interventions for adolescent sexual and reproductive health (ASRH) are increasingly using mobile phones but may not effectively report evidence.

OBJECTIVE: To assess strategies, findings, and quality of evidence on using mobile phones to improve ASRH by using the mHealth Evidence Reporting and Assessment (mERA) checklist recently published by the World Health Organization mHealth Technical Evidence Review Group.

DATA SOURCES: Systematic searches of 8 databases for peer-reviewed studies published January 2000 through August 2014.

STUDY SELECTION: Eligible studies targeted adolescents ages 10 to 24 and provided results from mobile phone interventions designed to improve ASRH.

DATA EXTRACTION: Studies were evaluated according to the mERA checklist, covering essential mHealth criteria and methodological reporting criteria.

RESULTS: Thirty-five articles met inclusion criteria. Studies reported on 28 programs operating at multiple levels of the health care system in 7 countries. Most programs (82%) used text messages. An average of 41% of essential mHealth criteria were met (range 14%–79%). An average of 82% of methodological reporting criteria were met (range 52%–100%). Evidence suggests that inclusion of text messaging in health promotion campaigns, sexually transmitted infection screening and follow-up, and medication adherence may lead to improved ASRH.

LIMITATIONS: Only 3 articles reported evidence from lower- or middle-income countries, so it is difficult to draw conclusions for these settings.

CONCLUSIONS: Evidence on mobile phone interventions for ASRH published in peer-reviewed journals reflects a high degree of quality in methods and reporting. In contrast, current reporting on essential mHealth criteria is insufficient for understanding, replicating, and scaling up mHealth interventions.

To cite: L'Engle KL, Mangone ER, Parcesepe AM, et al. Mobile Phone Interventions for Adolescent Sexual and Reproductive Health: A Systematic Review. *Pediatrics.* 2016;138(3):e20160884

REVIEW ARTICLE

Globally, mobile phone use is increasingly rapidly, and a large proportion of mobile phone subscribers are young people.[1,2] Four of every 5 citizens in developed countries and 1 of every 2 citizens in developing countries have a mobile phone subscription.[3] Young people ≤29 years of age are the most likely to own a mobile phone,[2,4] and 15- to 24-year-olds are more likely than older age groups to own a smartphone, indicating this group's eagerness to use new mobile technologies.[2,5,6] Given their popularity among youth, adolescent health professionals are increasingly using mobile phones to link young people to health information and services across global settings.[7–10]

This promising approach is called mHealth, the use of mobile phones to improve health knowledge, behaviors and outcomes, and it has advantages when used in health programming for young people. Adolescents commonly report low sexual and reproductive health (SRH) knowledge and risky sexual behaviors,[11,12] but they also face barriers to care such as provider bias and fear of stigma, refusal, and embarrassment in seeking information and services.[13–17] Mobile phone solutions may help overcome many of these barriers by providing accurate, timely, and engaging information and appropriate care for highly sensitive adolescent sexual and reproductive health (ASRH) topics. Mobile phones are inexpensive, portable, and accessible. They offer privacy in comparison with face-to-face meetings with health care providers, and they can provide young people with tailored and anonymous health information without stigma or judgment. Furthermore, young people are responsive to and excited about using new technologies for SRH promotion.[18–21]

Better assessments of mHealth solutions for young people are needed to rigorously evaluate whether they are a viable and effective strategy for reaching adolescents and improving ASRH behaviors in particular. Although a few published reviews have examined digital health solutions to ASRH, none have focused exclusively on mobile phone interventions and used a comprehensive definition of ASRH.[8–10] The goals of this research are to assess the strategies, findings, and reporting quality from evidence on mobile phone interventions for ASRH.

We conducted a systematic review of research from peer-reviewed journal articles by using the new mHealth Evidence and Reporting Assessment (mERA) checklist.[22] The checklist was developed by the World Health Organization mHealth Technical Evidence Review Group specifically to assess evidence from mobile phone intervention research for health improvement. The recently published mERA checklist is a valuable tool to assess the quality and completeness of intervention reporting for the many mHealth interventions for ASRH. Effective and comprehensive reporting may help improve program design, foster collaboration between service providers, reduce duplication of efforts, and ultimately increase the impact and ability to scale effective mHealth interventions for ASRH.

METHODS

Search Strategy

In August 2014 we searched 8 databases in the fields of medicine and social science: PubMed, Embase, Global Health, PsycINFO, Popline, Cochrane Library, Web of Science, and mHealthevidence.org. Search terms were grouped under 3 domains: adolescence, SRH, and mobile technology (Supplemental Table 6). Because our interest was in the intersection of these domains, the presence of ≥1 search term from each domain was required for

inclusion. We also hand-searched the references of 21 relevant systematic reviews. Finally, we issued a global call for resources on mHealth interventions for ASRH, which was widely promoted via social media, relevant electronic mailing lists, and partner Web sites.

Eligibility

We took an inclusive approach and used the World Health Organization definition of young people ages 10 to 24[23] and included peer-reviewed articles that either presented disaggregated data for young people 10 to 24 or did not disaggregate results but described the sample as having ≥70% of respondents between 10 and 24 years of age. We used the United Nations Family Planning Association definition of sexual and reproductive health,[24] which includes contraception, antenatal care, delivery, postnatal care, infertility, abortion, reproductive tract infections, HIV/AIDS, sexually transmitted infections (STIs), sexuality, and violence against women and related practices (eg, female genital mutilation). Included articles also had to describe the use of a mobile device, such as a mobile phone or tablet, to provide SRH information and support, and describe results or feedback from the mobile technology intervention. Systematic reviews, gray literature, documents that were not in English, and documents published before January 1, 2000 were excluded.

Literature Search Results

The Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) flow diagram was used to document the search strategy and article selection process (Fig 1).[25] A total of 5040 articles were retrieved from the 8 databases described above. After we removed duplicate articles and articles published before January 1, 2000, 2806 records remained.
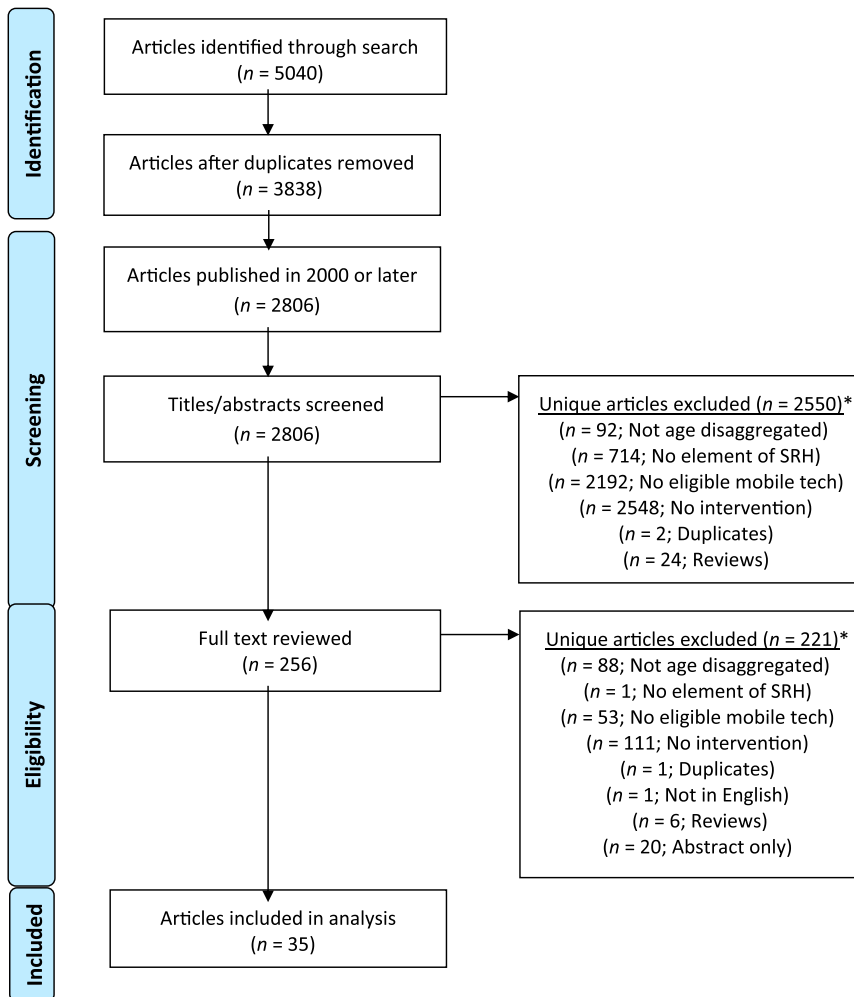
FIGURE 1
PRISMA flow diagram of article inclusion.

All 2806 titles and abstracts were screened and resulted in the exclusion of 2550 unique records; records could be excluded for multiple reasons. The full texts of the 256 remaining records were screened and resulted in the final inclusion of 35 articles. No additional articles meeting inclusion criteria were identified through the search of systematic reviews or through the global call for evidence.

Two reviewers screened a random selection of 11% of all abstracts (n = 300 out of 2806) for inclusion in the study. There was 94% agreement on article inclusion between the reviewers. Another check was conducted for 20% of documents (n = 50 out of 256) at the full text level. Again, this resulted in a high interrater reliability agreement of 92%. When reviewers did not agree, a third reviewer was consulted to make the final determination about whether the article met eligibility criteria for inclusion.

Data Extraction and Synthesis

One reviewer extracted data from included studies and a second reviewer independently confirmed accuracy. Data extraction for each article included name of the mHealth intervention program, study design, population, and aim, and key results. Study design (for each individual article) and program purpose (for each unique mHealth program) were used as classification

schemes for synthesizing data. Study designs were cataloged as randomized controlled trials (RCTs), quasiexperimental, observational, or descriptive research. Program purpose included health promotion campaign, curriculum addition, screening and follow-up service utilization, provider counseling, and patient adherence.

Grading

Evidence was graded according to the mERA checklist.[22] The core checklist defines 14 essential mHealth criteria to support completeness of reporting and replication of the mHealth intervention by addressing its content, context, and implementation features (Supplemental Table 7). In addition, mERA also provides a checklist for reporting on study methods, because the field of mHealth includes a range of research designs and methods. This second checklist defines 30 core elements of research reporting required to facilitate the synthesis of mHealth research findings, regardless of study design (Supplemental Table 8).

This manuscript is the first review of published literature to use the mERA checklist. Three reviewers were trained on the mERA checklist, and they graded 4 randomly selected articles to yield interrater reliability scores of 82%, 84%, 93%, and 95%, sequentially.

RESULTS

Program Strategies

The 35 articles reported on 28 different mHealth intervention programs where mobile phones were used to address ASRH. Three-quarters of all programs (n = 21) were implemented in the United States. Four were conducted in Australia or New Zealand, and 1 was conducted in the Netherlands. One program was implemented in Tanzania and 1 in the Democratic Republic of the Congo.

TABLE 1 Study Characteristics and Results for mHealth Health Promotion Campaigns

Author and Program	Study Design	Study Population	Study Aim	Results
Willoughby 2013[47], BrdsNBz	Descriptive, content analysis	US, North Carolina; $n = 1351$ text messages sent by youth to BrdsNBz service	Analyzed text messages sent to a sexual health text message service promoted to 14- to 18-y-olds to determine the types of questions asked of a confidential, accurate source of information.	89% of texts sought information about sexual health topics (89%), 7% asked for advice, and 4% asked for reassurance that the sender was developing normally. Questions asked mainly about sexual acts (33.9%), unplanned pregnancy (20.2%), contraception (13.7%), physical or sexual development (12.9%), and sexually transmitted diseases (10.8%).
Juzang 2011[43], HIV Prevention for Young Black/African-American Males in Philadelphia	Quasiexperimental, nonrandomized assignment to intervention or control group	US, Pennsylvania; $n = 60$; ages 16–20 y; convenience sample of young African American men recruited from community-based organizations in Philadelphia	Explored the feasibility and effectiveness of engaging young black men in a 12-wk SMS program aimed at HIV prevention.	There were significant changes or trends in 3 key outcomes: condom norms, sexual health awareness, and practicing monogamy. Condom norms were higher for the control group, but this finding may have been confounded by increased levels of monogamy. There was a significant increase in awareness of sexual health for the intervention group.
Perry 2012[21], Hookup	Descriptive, focus group discussions	US, California; $n = 26$, ages 15–20 y; convenience sample of 50% Latino and 35% African American, majority female teens recruited from 2 teen clinics in Los Angeles County	To understand adolescents' perspectives on the use of a preventive sexual health text messaging service.	Participants linked their enjoyment to the message content being informative (providing relevant and new information), simple (automatically limited to small words and short phrases), and sociable (easily able to be shared with friends).
Jones 2013[42], Love, Sex, and Choices	RCT	US, New Jersey; $n = 238$; ages 18–29 y; random sample of mostly African American women	Compared the 12-wk soap opera video series to 12-weekly HIV prevention text messages; both delivered to smartphones provided to participants to reduce HIV sex risk behavior among young, urban women.	The primary study outcome measure of unprotected vaginal and anal sex with a high-risk partner was significantly lower after intervention for both treatment arms ($P < .001$) compared with baseline. Although the differences between the soap opera video series and the comparison HIV prevention text messages were not statistically significant here, risk reduction was 18% greater for the video than the comparison treatment.
L'Engle 2013[20], M4RH	Observational, analysis of electronic data log and SMS questions	Tanzania; $n = 2870$; 56% female and ~60% ≤ 29 y old	Evaluate the feasibility, reach, and potential behavioral impact of providing family planning information via SMS to the general public in Tanzania.	During the pilot period, 2870 unique users accessed m4RH in Tanzania, resulting in 4813 queries about specific contraceptive methods. Younger users queried more methods than older users: Users ≤ 19 y old queried 2.9 contraceptive methods on average, compared with 2.6 methods among 20- to 29-y-olds, 2.1 methods among 30- to 39-y-olds and 1.7 methods among users ≥ 40 y old (F [3888] = 2.62, $P = .05$).
Vahdat 2013[30], M4RH	Observational, analysis of electronic data log, SMS questions, and telephone interviews	Kenya; $n = 4817$; 82% ≤ 29 y of age; majority of respondents female	To evaluate the acceptability, information access, and potential behavioral impact of providing contraception information via SMS to young people in Kenya.	During the pilot period, 4817 unique users accessed m4RH in Kenya. 22% were ≤ 19 y old, and 56% were 20–29. Condom and natural family planning information was accessed most frequently, although users queried all methods. 1 in 5 used the m4RH system to locate nearby clinics. Respondents liked simple language and confidentiality of mobile phone.
Nsakala 2014[46], Please Doctor	Descriptive, content analysis	Democratic Republic of Congo; $n = 1250$ calls and messages; calls placed from youth 14–24 y old; majority of callers female	To identify and address SRH concerns raised by young people through phone calls into a radio program.	Most questions came from 15- to 24-y-olds. Focus of girls' questions: menstrual cycle calculation (24%), sexual practices (16%), love relationships (15%), and virginity (14%). Boys' concerns are masturbation (and its consequences) (22%), sexual practices (19%), love relationships (18%), and worries about penis size (10%). Infections (genital and STI) and topics regarding HIV represent 9% and 4% of the questions asked by girls against 7% and 10% by boys.

TABLE 1 Continued

Author and Program	Study Design	Study Population	Study Aim	Results
Giorgio 2013[40], PPFA Chat/ Text Program	Quasiexperimental, pre–post test data obtained from IM and SMS questions	US, nationwide; $n = 32\,589$ SMS or chat conversations	To assess whether Planned Parenthood IM and SMS program was successful in reaching target population, whether user characteristics vary by mode (IM versus SMS), and whether mode is associated with level of worry by user.	A total of 32 589 conversations occurred during the program's first year. Users were most commonly white (46.17), aged 18–24 y (51.20%), and female (89.29). The program reached substantial numbers of Latino or Hispanic (18.59%) and black people (16.87%). Almost one-quarter of the users (23.30%) were aged ≤17 y. 78% of text questions concerned, in order of frequency, abortion, pregnancy testing, emergency contraception, and STI testing. After the study covariates were controlled for, there was no significant difference in the odds of feeling better (less worried) after the chat between IM and text message users.
Suffoletto 2013[55], Sexual Risk-Reduction Program	RCT	US, Pennsylvania; $n = 52$; ages 18–25 y; convenience sample of female patients recruited from an emergency department with hazardous drinking behavior and recent risky sexual encounters	To pilot test an SMS sexual risk reduction program among at-risk young women.	In the intervention group, there was an increase in the proportion with condom use with last vaginal sex from 20% to 53% and an increase in always condom use over the past 28 d from 0% to 33%. These changes were not statistically different from those of control participants but did show relative positive change for intervention versus control participants.
Levine 2008[84], SexINFO	Observational, analysis of electronic data log, focus group discussions, surveys	US, California; $n = 322$; ages 12–24 y; convenience sample of patients recruited from 3 clinics	To evaluate the viability of a sexual health text messaging service for at-risk youth.	Consistent positive associations were found between demographic risk factors for STIs and service awareness. African American youth, youth living in target areas, and participants 12- to 18-y-old were more likely to report awareness. 10% of youth who saw the campaign ad accessed the SexINFO service. The top 3 information choices concerned condom breaks, STIs, and concern about pregnancy.
Gold 2010[41], SMS Australia	Descriptive, focus group discussions	Australia, Victoria; $n = 43$; ages 16–24 y; convenience sample of youth recruited from the SMS 2008 project	To assess acceptability, utility, and efficacy of a sexual health SMS promotion campaign for youth.	Text messages were acceptable and personal, and youth liked informal language. Preference for positive, relevant, short, and varied messages. Higher recall of funny, rhymed, event-related messages. Youth said messages gave new information, reminded about existing information, and reduced apprehension about STI testing.
Lim 2012[45], SMS Australia	RCT	Australia, Melbourne; $n = 994$; ages 16–29 y; youth recruited from a daylong music festival	To evaluate effectiveness of SMS and e-mail messages on young people's sexual health-seeking behavior	At 12-mo follow-up, intervention group had higher STI knowledge than the control group (OR = 3.19; 95% CI, 1.52–6.69 male and OR = 2.36; 95% CI, 1.27–4.37 female). Women (but not men) were more likely to have an STI test (OR = 2.51; 95% CI, 1.11–5.69) and discuss SRH with clinician (OR = 2.92; 95% CI, 1.66–5.15). No significant impact on condom use.
Gazmarian 2014[32], Text4Baby	Observational, in-person and telephone surveys	US, Atlanta; $n = 468$; 54% were ages ≤25 y, and 91% were black; pregnant and postpartum women recruited from 2 Women, Infants, and Children clinics	To assess factors related to enrollment process and acceptability in a healthy pregnancy SMS program.	Women with higher income, higher education, and smaller households were more likely to successfully enroll in the text4baby program.

TABLE 1 Continued

Author and Program	Study Design	Study Population	Study Aim	Results
Song 2013[55]; TuTalk Milwaukee	Quasiexperimental, pre–post test data, focus group discussion	US, Wisconsin; n = 20; ages 14–28 y; 80% were African American; convenience sample of low-income expectant women recruited from prenatal clinic at Milwaukee Health Department	Feasibility of a 2-way SMS system for pregnancy-related questions for low-income minority women	Using the system increased levels of perceived pregnancy-related knowledge and facilitated patient–provider communication. Participants reported significant reductions in stress and depression and improved mental health after using the system. The system responded to most known questions quickly and accurately, and also encountered many new topics and linguistic expressions.

CI, confidence interval; IM, instant messaging; OR, odds ratio.

Eight programs focused on pregnancy; 4 of these aimed to increase adoption and correct use of contraceptive methods,[20,26–30] 2 focused on youth assets and broader pregnancy prevention messaging,[19,31] and 2 provided information to pregnant or parenting adolescents.[32,33] STIs were the focus of 8 programs, with most of them targeting links to services for STI vaccination,[34,35] screening,[36,37] or treatment.[10,34,38,39] Seven programs targeted general ASRH issues.[40–47] Five mHealth programs specifically focused on HIV/AIDS; 3 of them provided adherence support for HIV-positive youth,[48–51] and 2 focused on HIV prevention.[18,43,52,53]

Health promotion campaigns were the most common purpose of mHealth programs for ASRH included in the review (43%; n = 12). These programs provided a mobile phone platform for youth to text SRH questions to health professionals,[33,40,46,47] allowed adolescents to retrieve on-demand SRH content,[20,30,44] and offered "push" messaging where SRH content was texted to adolescents on a regular schedule.[21,32,41,43,45,51] Two programs complemented delivery of an in-person, evidence-based ASRH curriculum with a mobile phone component to extend program reach particularly to ethnic and minority youth and to stay current on the communication channels frequently used by young people.[18,19,52,53]

The 7 mHealth programs for screening and follow-up service utilization included human papillomavirus (HPV) vaccination text message reminders for follow-up,[34,35] notification for positive chlamydia and other STI results,[10,38,53,54] and chlamydia screening promotion.[36,37] Patient adherence to medications or health recommendations was addressed in 7 additional programs that provided text message reminders for taking daily oral contraceptive pills[27,28] or antiretroviral therapy (ART) for HIV-positive young people[49,50] and in programs that provided regular counseling over the mobile phone to improve adherence to contraception use and continuation[26,29] or adherence to ART for HIV-positive youth[48,51] or to delay subsequent pregnancy among adolescent mothers.[31]

Short message service (SMS) or text messaging was used by the majority of programs (82%, n = 23). Three programs added mobile phone voice calls,[39,46,54] and 4 programs used mobile phone voice calls exclusively.[26,29,31,48,51] Only a few programs used other communication formats, such as providing mobile phone videos,[42] e-mail,[37] instant messaging,[40] or sparse use of other multimedia applications.[18,52,53]

Study Findings

Research on health promotion interventions (Table 1) that provided a forum for asking SRH questions confidentially via mobile phone[33,40,46,47] found that adolescents texted about a wide range of highly sensitive SRH topics, suggesting robust acceptability and relevance of this strategy. Content analyses of text questions found that adolescents commonly asked about sexual acts and practices[46,47] physical and sexual development,[47] abortion,[40] and contraception and unplanned pregnancy.[40,47] However, a comprehensive array of SRH topics was mentioned in adolescents' texts.

Health promotion campaigns that provided on-demand or pushed out mobile phone messages were found to be highly acceptable to young people[20,21,29,32,41,43–45,55] because they liked the confidentiality of mobile phone communication[30] and found the SRH content simple to understand,[21,30] informative,[21,41,55] and easily shared.[21,30] Furthermore, research on these campaigns along with a study on a mobile phone curriculum addition[53] (Table 2) demonstrated that mHealth

TABLE 2 Study Characteristics and Results for mHealth Curriculum Additions

Author and Program	Study Design	Study Population	Study Aim	Results
Cornelius 2011[52]; BART Booster	Observational, analysis of electronic data log, group discussions	US, Southeast; n = 12; ages 13–18 y; convenience sample of African American teens, majority female	To develop and pretest multimedia and SMS messaging as boosters for evidence-based HIV prevention curriculum (BART), in a 3-wk theater test of platform.	Teens indicated interest in receiving safer sex information in natural setting, via mobile, and in familiar language. Technical challenges in message delivery were identified and corrected. Over 3-wk testing period, observed average of 80% response to text messages.
Cornelius 2012[18]; BART Booster	Descriptive, focus group discussion	US, Southeast; n = 11; age 13–18 y; convenience sample of African American teens, equal numbers male and female	Examine African American adolescents' perceptions of a mobile phone–enhanced BART booster intervention.	Adolescents liked the approach of using mobile phones to provide HIV messages. Preferred message delivery 1 per d. Perceived benefits were ease of use, anonymity, confidentiality, and support on demand.
Cornelius 2013[53]; BART Booster	Quasiexperimental, longitudinal 1-group comparison with baseline and 2 follow-ups	US, Southeast; n = 40; ages 13–18 y; convenience sample of African American teens recruited from community organizations and schools, equal numbers male and female	Whether change in beliefs and sexual behavior among African Americans could be achieved through a mobile phone HIV prevention intervention.	Greater HIV knowledge, improved attitudes toward condoms, and increased perceived HIV risk scores were observed with older adolescents (16–18 y old). Reported decrease in engaging in unprotected sexual intercourse from 31 times at baseline to 19 times after intervention and then only 9 times at the 3-mo follow-up.
Devine 2014[19]; Teen Outreach Program	Observational, analysis of electronic data log, focus group discussions	US, Colorado; n = 96; ages 14–18 y; convenience sample of 70% Latino and 24% African American teens, majority male, recruited from Boys and Girls Clubs of Colorado	To develop and pilot a theory-based mobile phone texting component attractive to minority youth as a supplement to the evidence-based Teen Outreach Program, a youth development program for reducing teen pregnancy and school dropout.	Teens were enthusiastic about text messages complementing Teen Outreach Program. Results also revealed barriers: access to mobile phones, retention as measured by completion of the postpilot survey, and a need to be attentive to teen literacy. Observed a 49% response to text messages and a decrease in response rates over time. Messages were viewed as too frequent and revised to send 3–7 per week.

BART, becoming a responsible teen.

intervention exposure was associated with increased sexual health knowledge and awareness,[33,43,45,53] lower rates of unprotected sex and higher rates of condom use,[42,53,55] and greater STI testing.[45]

Several studies of health promotion campaigns investigated levels of mHealth program access among adolescents and lower-income and minority subgroups. Results pointed to a few programs that have successfully reached the general youth population in Africa[20,30,46] and specific youth subgroups at higher risk of negative SRH outcomes in the United States.[40,44] For example, more than half of the Planned Parenthood Federation of America (PPFA) Chat/Text program users in year 1 were African American,

Latino, or from other ethnic or racial minority groups,[40] and the Mobile for Reproductive Health (m4RH) program in Kenya found that 22% of users were ≤19 years old, and an additional 56% were 20 to 29 years old.[30] On the other hand, research on Text4Baby in the United States showed that younger women with lower income and education were less likely to enroll in the subscription-based text message program for pregnant or parenting women than older, higher-income, and better-educated women.[32]

Studies of mHealth applications for screening and follow-up for STIs (Table 3) documented improved submission of biological samples for screening in Australia[36] and the Netherlands[37] and timely recall and

treatment of youth who test positive for STIs in New Zealand,[56] Australia,[38] and the United States.[39,54] An important finding from the Stamp Out Chlamydia program in Australia is that combining text messages with a small financial incentive to encourage screening resulted in a dramatically reduced time period for recruitment, from collecting 638 specimens in 6 months to collecting 472 specimens in just 4 days.[36] Finally, 2 studies of HPV vaccination reminders sent via SMS to parents or teens in the United States yielded higher rates of receiving second and third doses of the HPV vaccine and more timely completion of the HPV vaccine series.[34,35]

Using the mobile phone to place calls to adolescent patients to conduct

TABLE 3 Study Characteristics and Results for mHealth Screening and Follow-Up Service Utilization

Author and Program	Study Design	Study Population	Study Aim	Results
Lim 2008[56]; Chlamydia Results Notification	Quasiexperimental, text messaging cases compared with historic phone and letter controls	New Zealand; n = 303; ages ≥14 y and majority female; convenience sample of chlamydia test results from an urban sexual health clinic	Evaluate whether sending test results via SMS can reduce time to treatment of chlamydia.	Between March and August 2007, 237 text messages were sent, with 93% successfully delivered. Median time to treatment similar in both groups showed texts worked just as well. There was a trend to earlier treatment between those with mobile phones compared with those without (t = −1.300, P < 0.1).
Dokkum 2012[37]; Chlamydia Screening Implementation SMS	Observational, analysis of national registry data	Netherlands; round 1, n = 52 628; round 2, n = 41 729; ages 16–29 y, majority female; convenience sample of youth recruited through a population-based chlamydia screening program	Evaluate the contribution of automated reminders by letter, e-mail, and SMS on package request and sample return in an Internet-based chlamydia screening.	Willingness to provide a mobile phone number was very high. Providing mobile number was slightly associated with chlamydia risk factors (ORs ≤1.7). The proportion of invitees returning a sample increased significantly after e-mail or SMS reminder (10%–14% round 1; 7%–10% round 2).
Matheson 2014[35]; HPV Vaccination Reminders Durham NC	Quasiexperimental, comparison of SMS reminders to standard care and "interested" but not enrolled group	US, North Carolina; n = 312; ages 11–22 y; convenience sample of HPV vaccine–eligible patients (majority female) and their caregivers who initiated the HPV vaccine series	To assess whether text message reminders sent to patients or parents in a busy urban clinic would increase HPV vaccination series completion rates.	14% of participants receiving SMS reminders completed vaccine series on time, compared with 0% of interested group and 3% of standard care group. Significant differences were found on completing HPV2, HPV3, and HPV3 at the optimal time (all P < .05).
Kharbanda 2011[34]; HPV Vaccination Reminders NYC	Quasiexperimental, comparison of receiving SMS reminders to unenrolled and historical control group	US, New York; n = 1512; convenience sample of parents of adolescents 9–20 y old who received HPV1 or HPV2 vaccine from 9 pediatric clinical sites in New York City	To implement and evaluate sending up to 3 weekly text message reminders for the second (HPV2) and third (HPV3) vaccine doses.	Comparing children of parents who enrolled with those who did not, on-time receipt of next HPV vaccine dose occurred among 51.6% (95% CI, 42.8%–60.4%) versus 35.0% (95% CI, 29.6%–40.2%) of adolescents (P = .001). Among a historical cohort of adolescents, receiving HPV1 or HPV2 in the 6 months before the intervention period, on-time receipt of next vaccine dose was noted for 38.1% (95% CI, 35.2%–41.0%) (P = .003). Increases in receipt of next vaccine dose among intervention subjects were sustained at 4 mo after the vaccine due date.
Currie 2010[36]; Stamp Out Chlamydia SMS	Observational, analysis of screening and recruitment data	Australia; n = 2786; ages 16–25 y; convenience sample of students recruited from 2 universities and 1 institute of technology in Australia	To determine whether text messaging and financial incentives would increase tertiary student participation in chlamydia screening	In Phase 1, 22.5% of students provided urine specimens for chlamydia testing; in phase 2, the dissemination of 866 text messages resulted in urine specimens from 45.3% of students. In phase 1, 638 specimens were obtained in 6 mo; in phase 2 472 specimens were obtained in just 4 d. During phase 2 (4 d) education and screening were offered via text messages; nonfinancial incentives were offered during phase 1, and a $10 cash incentive was offered during phase 2. Uptake in screening could have been a result of the financial incentive offered during phase 2 which was not offered in phase 1.
Huppert 2012[39]; STI Follow-Up Ohio	Quasiexperimental, quality improvement study with interventional 2 × 2 factorial design with replication	US, Ohio; n = 97; ages 14–21 y; convenience sample of female patients recruited from the emergency department at Cincinnati Children's Hospital Medical Center	To improve ability to contact adolescent women with positive STI results after an emergency department visit.	After intervention, documentation of a confidential phone number increased from 25% to 58%, contacts increased from 45% to 65%, and loss to follow-up decreased from 40% to 24%. Use of a card prompting women to call for results together with a cell phone improved successful outcome within 7 d.

TABLE 3 Continued

Author and Program	Study Design	Study Population	Study Aim	Results
Reed 2014[54], STI Follow-Up Ohio	Quasiexperimental, quality improvement study with interventional 2 × 3 factorial design with replication	US, Ohio; n = 386; ages 14–21; female patients recruited from the emergency department at Cincinnati Children's Hospital Medical Center	To improve adolescent notification of positive STI tests by using mobile phone technology and STI information cards.	Successful notification was significantly greater for call + text message versus call only (OR 3.1; 95% CI, 1.4–6.9). There was no significant interaction between card and method of notification. Texting only or type of STI information card was not significantly associated with patient notification. In total, 94% of those with a documented confidential phone number who received call + text message were notified of their positive STI results within 7 d of their emergency department visit.
Bailey 2014[38], Text 2 Treat	Observational, analysis of clinic records	Australia, Geraldton, Western Australia; n = 64; convenience sample of patients with genital chlamydia cases recruited from the sexual health unit of Population Health–Midwest	Assess feasibility of using SMS to recall clients with STIs	94% of clients responded to the SMS, with 84% responding on the same day they were contacted. All clients were treated for their infection, with 72% having directly observed treatment within 1 day of being informed of their results via SMS.

CI, confidence interval; OR, odds ratio.

provider counseling (Table 4) appeared to have limited utility. Two RCTs tested the impact of cell phone calls as a mechanism to improve adolescents' contraception use.[26,29] Both studies took place in the United States. In the California study, calls to 805 adolescents were difficult to complete, and there was no significant impact on contraceptive use, attendance or satisfaction with the clinic, or pregnancy and STI rates[29]; in the Texas study, mobile phone calls to 1115 young people showed no significant impact on adherence to oral contraceptive pills or condom use at last intercourse.[26] A third study of 249 adolescent mothers in Washington, DC that relied on mobile phone calls alone showed low feasibility, with only half of the sessions completed and nonsignificant outcome results from intent-to-treat analyses.[31] The remaining program that relied on this intervention approach targeted HIV-positive youth and demonstrated a significant impact on medication adherence and viral load, although the sample size was only 37 participants.[48]

In contrast, interventions that used text messaging as the primary strategy to increase patient adherence (Table 5) were associated with increased oral contraceptive pill knowledge[28] and continuation[27] and ART adherence in a small observational study of 87 HIV-positive youth.[50]

Range and Quality of Evidence

Articles included in the review reflected study designs across the research spectrum along with variable quality of research reporting (Fig 2). RCTs (n = 9) on average met nearly half (47%) of the essential mHealth criteria and the highest percentage of methodological criteria (93%) of all study designs. Quasiexperimental studies (n = 11) on average met the lowest percentage of essential mHealth criteria (35%) but 80% of

TABLE 4 Study Characteristics and Results for mHealth Provider Counseling

Author and Program	Study Design	Study Population	Study Aim	Results
Belzer 2014[48]; AdTriNet YLHIV Adherence Facilitators	RCT	US, nationwide; n = 37; ages 15–24 y; 62% male and 70% African American; convenience sample of youth living with HIV recruited from 5 Adolescent Trials Network for HIV/AIDS Interventions sites	Whether youth living with HIV receiving cell phone support Monday through Friday demonstrated improved adherence and viral control during the 24-wk intervention and 24 wk after intervention compared with controls.	Mean self-reported adherence was significantly higher in the intervention group at 24 and 48 wk over the past 3 mo (P = .021), 1 mo (P = .007), past week (P = .036), and past weekend (P = .035). Self-reports of ≥90% adherence over the past 3 mo (P = .046), last 1 mo (P = .020), last week (P = .028), and last weekend (P = .017) were significantly higher in the intervention group. Mean log 10 viral load was significantly lower in the intervention group than in the control group at 24 wk (2.82 vs 4.52; P = .002) and at 48 wk (3.23 vs 4.23; P = .043).
Puccio 2006[51]; AdTriNet YLHIV Adherence Facilitators	Observational, regular phone surveys and laboratory data	US, California; n = 8; ages 16–24 y; convenience sample of majority male HIV-positive youth recruited from a health facility and known to the research team	Evaluate the practicality and acceptability of weekly mobile phone call reminders to help HIV-positive youth adhere to ART.	Participants found calls to be helpful, and level of intrusion into daily lives was acceptable. Little staff time is needed for making calls. A 12-wk intervention was not adequate for most participants. Protocol should allow >3 missed calls for each participant.
Kirby 2010[29]; Project Reach California	RCT	US, California; n = 805; ages 14–18 y; young women attending a reproductive health clinic in San Francisco	Whether follow-up phone calls from health care practitioners to address young women's concerns can help sustain contraceptive use.	Clinic counselors completed only 2.7 calls per patient and made 7.8 attempts for every completed call. The project did not influence contraceptive behavior, clinic attendance, satisfaction with the clinic, or rates of pregnancy and STDs.
Berenson 2012[26]; Texas OCP Reminder Calls	RCT	US, Texas; n = 1115; ages 16–24 y; female patients attending a reproductive health clinic and requesting OCPs in southeast Texas	To examine the effect of clinic-based intervention and a clinic-based plus telephone intervention on contraceptive adherence among young women initiating use of OCPs	The intervention did not have a significant effect on OCP continuation after 3 mo, 6 mo, or 12 mo. Condom use at last sexual intercourse did not differ by intervention. No effect was observed on pregnancy and STI rates or mean number of correctly used pill packs.
Katz 2011[31]; NIH-DC Girl Talk	RCT	US, Washington, DC; ages 15–19 y; primiparous pregnant teens, 88% African American, recruited from prenatal clinics and local high schools	To test the efficacy of weekly cell phone counseling sessions on preventing repeat teen pregnancies.	There was no difference in time to pregnancy in intent-to-treat analyses. Among teens 15–17 y old only, increasing treatment intensity was significantly associated with longer time to subsequent pregnancy (hazard ratio = 0.987; 95% CI, 0.977–0.997; P = .013). The mean number of sessions completed over the 18-mo counseling period was 20 ± 12 sessions, or a mean percentage of 52% of the possible sessions.

CI, confidence interval; OCP, oral contraceptive pill.

methodological criteria. Observational studies (n = 10) on average met 40% of essential mHealth criteria and 73% of methodological criteria. Descriptive studies (n = 5) on average met nearly half of the mHealth criteria (47%) but only 82% of methodological criteria.

Across all 35 studies, fewer criteria for essential mHealth reporting were met than criteria for methodological reporting. In the mERA checklist for mHealth reporting, an average of 41% (range 14%–79%) of criteria was achieved among all 35 studies

(Fig 3). The mHealth criteria least commonly reported were contextual adaptation (11%) and cost assessment (17%). Only 3 mHealth reporting criteria were met in more than half of studies: intervention delivery (91%), intervention content (60%), and infrastructure (57%). In the mERA reporting and methodology checklist, an average of 82% (range 52%–100%) of criteria were met across all 35 studies (Fig 4). However, only about half of all graded articles met the criteria for assessing bias, calculating sample

size, or having a comparator, and only one-third met criteria for presentation of the study logic model or consideration of generalizability of research findings.

Sample sizes and recruitment strategies were diverse, reflecting varied study designs and study aims. Sample sizes ranged from 8 respondents in a study to improve medication adherence among HIV-positive youth in California[51] to 52 628 youth who were contacted to undergo chlamydia screening

TABLE 5 Study Characteristics and Results for mHealth Patient Adherence Programs

Author and Program	Study Design	Study Population	Study Aim	Results
Castano 2012[27]; PPFA OCP Reminder Texts	RCT	US, New York; n = 962; ages ≤25 y; young women recruited from a Planned Parenthood health center	To estimate whether daily educational text messages affect OCP continuation at 6 mo.	At follow-up, 64% of intervention group were still OCP users, compared with 54% of control group (P = .005). Participants receiving intervention were more likely to continue OCP use at 6 mo (OR = 1.55; 95% CI, 1.03–2.00), in analysis adjusted for age, race, ethnicity, age at first sex, pregnancy history, and OCP experience. Six-month OCP use improved by 10% in intervention versus control group.
Hall 2013[28]; PPFA OCP Reminder Texts	RCT	US, New York; n = 659; ages 13–25 y; young women recruited from a Planned Parenthood health center	To estimate whether daily educational text messages affect OCP knowledge at 6 mo.	Mean OCP knowledge scores improved over time for all women (baseline 22.8, 56% correct vs 24.7, 60% at 6 mo), including knowledge of OCP mechanisms of action (P = .004), effectiveness (P < .001), side effects (P = .03), and benefits (P < .001). Mean 6-mo scores were greater in the intervention (25.5) than the control group (23.7) (P < .001). Text message intervention most strongly predicted OCP knowledge (β = 1.6; 95% CI, 0.9–2.2).
Hailey 2013[50]; STAR TRACK ST-AMP	Observational, analysis of self-reported adherence data	US, Maryland; n = 87; ages 15–24 y; convenience sample of mostly African American and male primary care patients recruited from a the STAR TRACK clinic	To evaluate whether STAR TRACK Adherence to Medication text and video messaging program improves adherence to ART and HIV care.	Before ST-AMP was implemented, patient self-reports indicated that their adherence to ART was roughly 40%–50%; in patients enrolled in ST-AMP, overall ART adherence increased to ~80% within 24 mo.
Dowshen 2013[49]; YLH Philadelphia	Observational, analysis of electronic data log and SMS responses, periodic interviews assessing self-reported adherence	US, Pennsylvania; n = 25; ages 14–29 y; convenience sample of HIV-positive youth, 60% African American and majority male, recruited from a community center for lesbian, gay, bisexual, and transgender youth	To assess the feasibility and validity of daily ITR as a measure of adherence to ART among youth living with HIV.	Participants responded to medication prompts ~61% of the time. The overall mean ITR adherence rate (ie, positive responses) was 57.4% (SD = 28.5%); ITR and visual analog scale measures were moderately positively correlated (r = 0.52, P < .05) during the first 6 wk of the study period. ITR adherence rates were significantly higher on weekdays than on weekends (P < .05). ITR method provides a helpful tool to identify and respond to adherence challenges in real time.

CI, confidence interval; ITR, interactive text message response; OCP, oral contraceptive pill; OR, odds ratio.

in an observational study in the Netherlands.[37] Most studies recruited youth participants from health care facilities and clinics, several used community organizations and schools, and population-based studies relied on national registries, mass media advertising, and community events such as music festivals.

DISCUSSION

mHealth Program Strategies

The diversity and ingenuity of mHealth intervention programs identified in this review reflect how ASRH professionals are embracing mobile phones to improve adolescents' health at myriad levels of the health care system. The interventions identified for this review aimed to promote positive and preventive SRH behaviors, increase adoption and continuation of contraception, support medication adherence for HIV-positive young people, support teen parents, and encourage use of health screening and treatment services. Mobile phones were used to increase health program reach to adolescents and ethnic and minority subgroups, increase confidentiality in providing sensitive SRH information to young people, and provide a supportive "friend in your pocket" who reminds and encourages good health.

The large majority of mHealth interventions for ASRH relied on SMS platforms. Notably, only 4 mHealth programs included in this review used other technological communication formats in place of or in addition to SMS. From a programmatic lens this is a strategic and defensible choice because SMS remains the most frequently used mobile phone communication format among youth in the world and is often cost-effective, costing just pennies per text at implementation.[2,5,57] However, text messaging requires clear and concise content within the 160-character restrictions of SMS and basic literacy for reading and understanding message content. Overall, mHealth interventions demand substantial attention to the user interface and content
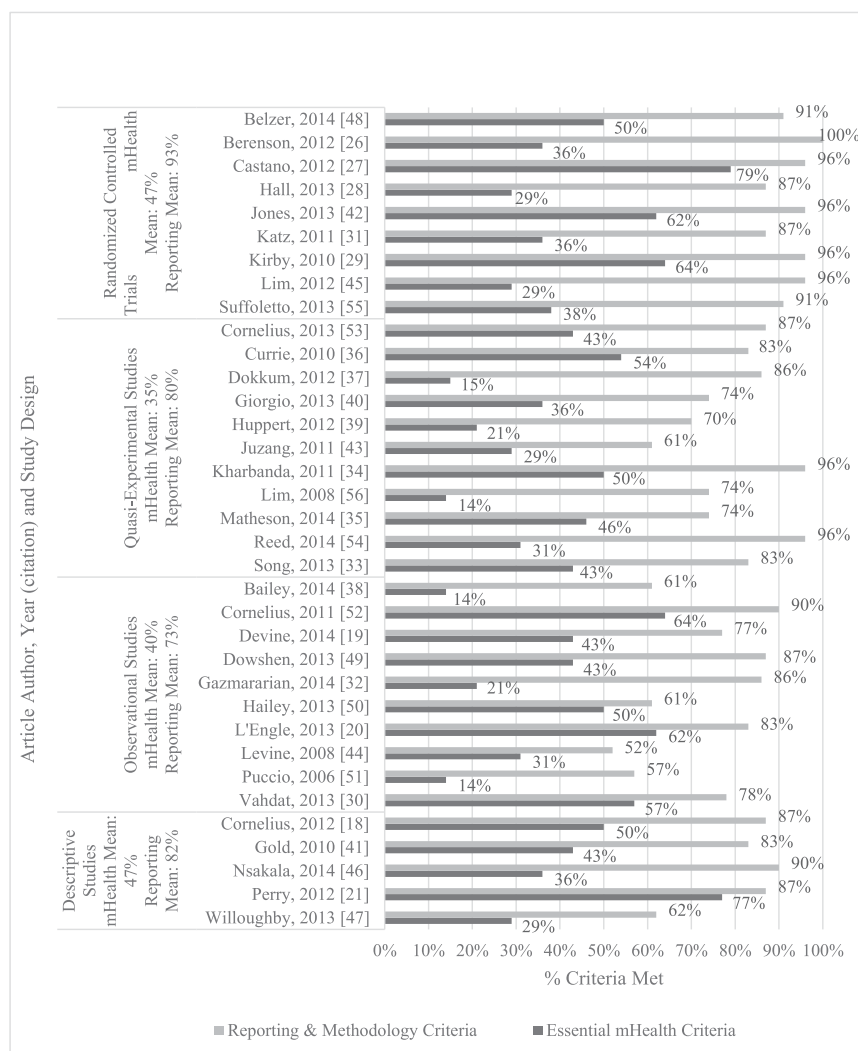
FIGURE 2
Percentage of mERA reporting criteria met, by article and study design.

delivery, yet there is limited knowledge of best practices in mobile phone communication for health promotion.[58] Because smartphone and Internet adoption is increasing globally, ASRH professionals should give greater consideration to message content, developing and testing additional communication formats, and criteria for evaluating these innovations.

Summary of Evidence

Although the mHealth field has been criticized for producing limited evidence about efficacy and effectiveness of mHealth interventions,[59–61] a variety of robust research designs and methods were used in the 35 studies we identified. The 9 RCTs tested the impact of the mHealth intervention on SRH knowledge, sexual behavior, medication adherence, and contraception use, among other ASRH outcomes. Many of the 11 quasiexperimental studies focused on quality improvement of health service delivery and relied on uptake of health screening and treatment services to assess effectiveness of the mHealth intervention. The 10 observational research studies tended to focus on implementation of the mHealth program to track reach and adoption by using a variety

of methods such as electronic data monitoring, analysis of national registry data, in-person interviews, and phone calls to participants. The 5 descriptive studies used qualitative methods such as focus group discussions but also content analyses of SRH questions posed by adolescents to assess reactions to intervention content or delivery. This variety of research designs, methods, and aims indicates the development of a robust evidence base at the intersection of mobile phones and ASRH.

Findings from the reviewed studies provide support for distinct uses of mobile phones to improve ASRH. First, health promotion campaigns implemented with text messaging evidenced robust acceptability and relevance for young people globally and led to improved SRH knowledge, less unprotected sex, and more STI testing. Additionally, young people across races and genders accessed these health promotion programs, suggesting excellent reach into the general youth population and key youth subgroups. Data from both higher-income countries and lower-income countries (LICs) suggests widespread youth access, although caution is needed in reaching conclusions about young people in LICs because few of the included studies were conducted in these settings. Second, leveraging mobile phones to increase youth contact for STI screening and follow-up yielded higher rates of screening and recall and more timely and complete STI treatment and vaccination. These results were found across this body of research conducted in Australia, the Netherlands, New Zealand, and the United States. Third, using text messaging to increase adolescent patient adherence to medication (oral contraceptive pills and ART) was shown to be promising in experimental research conducted with adolescents in the United States. However, using mobile phone
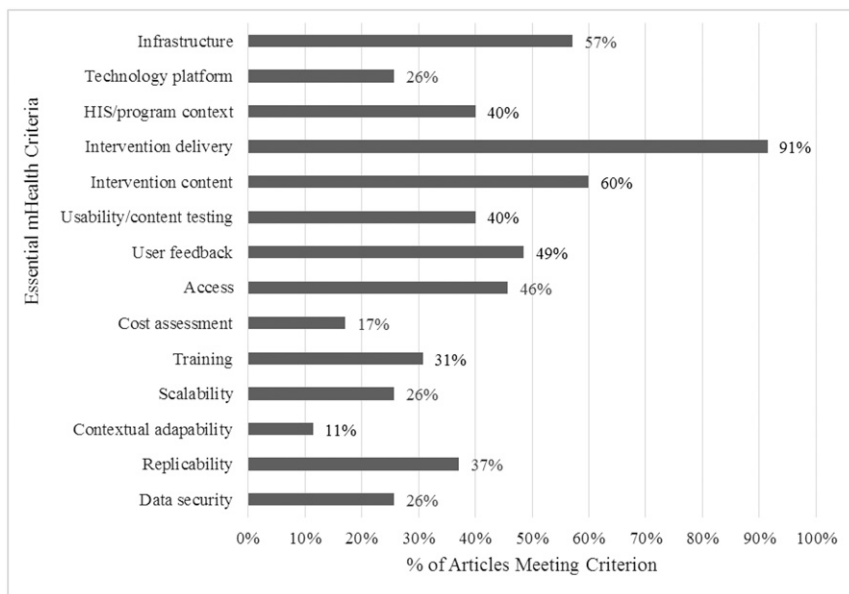
L'ENGLE et al

FIGURE 3
Percentage of articles that met mERA essential mHealth criteria. HIS, health information system.
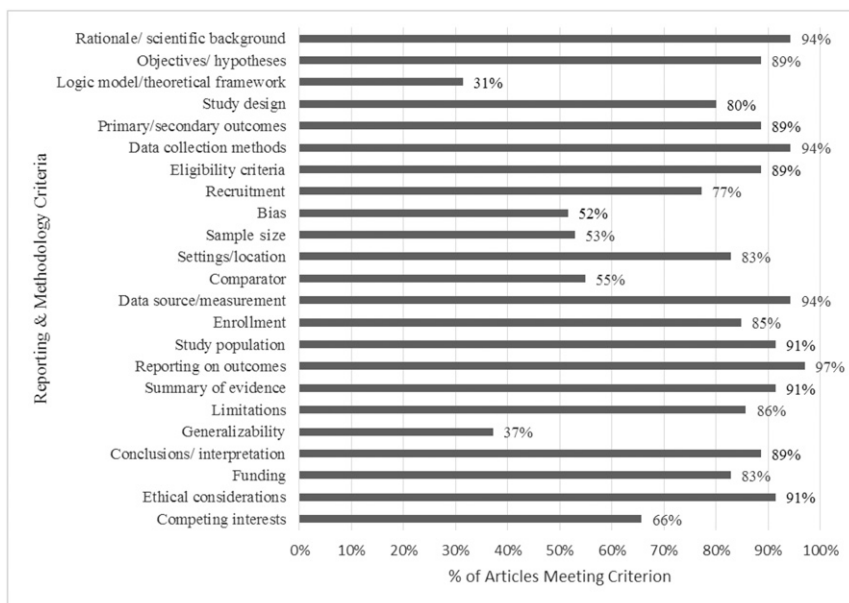

FIGURE 4
Percentage of articles that met mERA reporting and methodology criteria.

calls to provide adolescent patient counseling was ineffective, except for 1 small study of HIV-positive young people. Therefore, results from this review suggest that programs that aim to improve adolescents' adherence to medication should use text messaging rather than phone calls for reminders and support and that more research

should be conducted in this important area.

mERA Checklist

The mERA checklist provided a valuable platform for assessing the range and quality of reporting on mHealth interventions for ASRH. Notably, twice the percentage of mERA reporting and methodology

criteria were met (81%) compared with essential mHealth criteria (41%), reflecting a high degree of reporting and methodology quality in the 35 reviewed studies and a lower level of reporting completeness on essential features of the mHealth intervention. Guidelines for research reporting are widely available, and our results suggest high dissemination of reporting standards regardless of study design. On the other hand, reporting on mHealth programs is new, and the mERA checklist is the first reporting tool available for complete and transparent reporting on mHealth intervention research. Therefore, low scores for essential mHealth reporting are unsurprising. Increased dissemination and adoption of the mERA checklist will facilitate better reporting and improved ability to synthesize evidence on mHealth interventions.

Only 3 articles in this review studied mHealth interventions for young people in LICs.[20,30,46] The dearth of peer-reviewed evidence from LIC contexts is concerning, especially in light of the high use of mobile phones in these settings and existing reports that have identified many mobile phone interventions in LICs.[62,63] Robust research is needed to make evidence-based recommendations about the strategic use of mobile phones to improve ASRH in LICs, where limited resources make the need for evidence about impactful and cost-effective programs even more pressing. It is possible that our search strategy failed to identify peer-reviewed studies from LICs, although the global call for resources was disseminated through numerous channels to tap health researchers and programs in both high-income countries and LICs. In addition, we may have inadvertently excluded eligible articles during screening, and relevant studies

may have been discounted because they were not published in peer-reviewed journals or in English, in accordance with our study eligibility requirements. Finally, the mERA checklist is in its infancy, and this review is the first to apply the criteria in their entirety and with some of the rigor of the PRISMA guidelines, and therefore mERA grading results should be considered with caution.

CONCLUSIONS

This review highlights many innovative, youth-engaging, and effective uses of mobile phones to improve ASRH globally, but room remains for additional evidence and innovation. Research on mHealth interventions increasingly uses robust research designs and is accumulating evidence about the potential impact on ASRH knowledge, behavior, and service utilization. Yet the evidence base would benefit from larger sample sizes, more experimental studies, and primary outcomes focused on a variety of SRH norms and behaviors. Conducting this research in LICs is imperative.

Additional research also is needed to determine the optimal communication format for mobile phone interventions for ASRH. Data on the cost and cost-effectiveness of mHealth interventions for improving ASRH outcomes, along with cost-effectiveness data comparing mobile phones with other communication channels (such as in-person counseling or community outreach events) also would be beneficial. Finally, as the field matures, we hope the mERA checklist will serve as an important tool to support mHealth evidence evaluation, synthesis, and generation of best practices for adolescents' health.

ACKNOWLEDGMENTS

We thank Kate Plourde for support with gathering resources and abstracting studies, and Garret Mehl, Tigest Tamrat, and Lianne Gonsalves for support on search terms and the global call for resources. Details of how to obtain additional data from the study (codebook and dataset) are available from the corresponding author.

ABBREVIATIONS

ART: antiretroviral therapy
ASRH: adolescent sexual and reproductive health
HPV: human papillomavirus
LIC: lower-income country
m4RH: Mobile for Reproductive Health
mERA: mHealth Evidence and Reporting Assessment
mHealth: mobile phone interventions for health improvement
PRISMA: Preferred Reporting Items for Systematic Review and Meta-Analyses
RCT: randomized controlled trial
SRH: sexual and reproductive health
SMS: Short Message Service
STI: sexually transmitted infection

REFERENCES

1. International Telecommunication Union (ITU). ICT Facts & Figures: The World in 2015. Geneva, Switzerland: ITU; 2015. Available at: www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2015.pdf

2. Pew Research Center. Emerging Nations Embrace Internet, Mobile Technology. Washington, DC: Pew Research Center; 2014. Available at: www.pewglobal.org/files/2014/02/Pew-Research-Center-Global-Attitudes-Project-Technology-Report-FINAL-February-13-20147.pdf

3. GSMA. The Mobile Economy 2015. Available at: www.gsmamobileeconomy.com/GSMA_Global_Mobile_Economy_Report_2015.pdf

4. International Telecommunication Union (ITU). The World in 2011: ICT Facts and Figures. Geneva, Switzerland: ITU; 2011. Available at: www.itu.int/ITU-D/ict/facts/2011/material/ICTFactsFigures2011.pdf

5. Nielsen Company. Mobile Youth Around the World 2010. Available at: www.nielsen.com/us/en/insights/reports/2010/mobile-youth-around-the-world.html.

6. Lenhart A. *Teens, Social Media, & Technology Overview 2015*. Washington, DC: Pew Research Center; 2015, Available at: www.pewinternet.org/files/2015/04/PI_TeensandTech_Update2015_0409151.pdf

7. Gonsalves L, L'Engle KL, Tamrat T, et al. Adolescent/Youth Reproductive Mobile Access and Delivery Initiative for Love and Life Outcomes (ARMADILLO) Study: formative protocol for mHealth platform development and piloting. *Reprod Health*. 2015;12(67):67

8. Hightow-Weidman LB, Muessig KE, Bauermeister J, Zhang C, LeGrand S. Youth, technology, and HIV: recent advances and future directions. *Curr HIV/AIDS Rep*. 2015;12(4):500–515

9. Jones K, Eathington P, Baldwin K, Sipsma H. The impact of health education transmitted via social media or text messaging on adolescent and young adult risky sexual behavior: a systematic review of the literature. *Sex Transm Dis*. 2014;41(7):413–419

10. Lim MSC, Hocking JS, Hellard ME, Aitken CK. SMS STI: a review of the uses of mobile phone text messaging in sexual health. *Int J STD AIDS*. 2008;19(5):287–290

11. Mulye TP, Park MJ, Nelson CD, Adams SH, Irwin CE Jr, Brindis CD. Trends in adolescent and young adult health in the United States. *J Adolesc Health*. 2009;45(1):8–24

12. Xu JS, Shtarkshall R. Determinants, outcomes and interventions of teenage pregnancy: an international perspective. *Reprod Contracept*. 2004;15(1):9–18

13. Biddlecom AE, Munthali A, Singh S, Woog V. Adolescents' views of and preferences for sexual and reproductive health services in Burkina Faso, Ghana, Malawi and Uganda. *Afr J Reprod Health*. 2007;11(3):99–110

14. Chandra-Mouli V, McCarraher DR, Phillips SJ, Williamson NE, Hainsworth G. Contraception for adolescents in low and middle income countries: needs, barriers, and access. *Reprod Health*. 2014;11(1):1

15. Delany-Moretlwe S, Cowan FM, Busza J, Bolton-Moore C, Kelley K, Fairlie L. Providing comprehensive health services for young key populations: needs, barriers and gaps. *J Int AIDS Soc*. 2015;18(2 suppl 1):19833

16. Kerr JC, Valois RF, Diclemente RJ, et al. HIV-related stigma among African-American youth in the Northeast and Southeast US. *AIDS Behav*. 2014;18(6):1063–1067

17. Tilson EC, Sanchez V, Ford CL, et al. Barriers to asymptomatic screening and other STD services for adolescents and young adults: focus group discussions. *BMC Public Health*. 2004;4(21):1–8

18. Cornelius JB, St Lawrence JS, Howard JC, et al. Adolescents' perceptions of a mobile cell phone text messaging–enhanced intervention and development of a mobile cell phone-based HIV prevention intervention. *J Spec Pediatr Nurs*. 2012;17(1):61–69

19. Devine S, Bull S, Dreisbach S, Shlay J. Enhancing a teen pregnancy prevention program with text messaging: engaging minority youth to develop TOP ® Plus Text. *J Adolesc Health*. 2014;54(3 suppl):S78–S83

20. L'Engle KL, Vahdat HL, Ndakidemi E, Lasway C, Zan T. Evaluating feasibility, reach and potential impact of a text message family planning information service in Tanzania. *Contraception*. 2013;87(2):251–256

21. Perry RCW, Kayekjian KC, Braun RA, Cantu M, Sheoran B, Chung PJ. Adolescents' perspectives on the use of a text messaging service for preventive sexual health promotion. *J Adolesc Health*. 2012;51(3):220–225

22. Agarwal SA, LeFevre AE, Lee J, et al. Guidelines for reporting mHealth evidence: the mHealth Evidence Reporting and Assessment (mERA) tool. *BMJ*. 2016;352:i1174

23. World Health Organization (WHO). *The Health of Youth Document A42/Technical Discussions/2*. Geneva, Switzerland: WHO; 1989

24. United National Family Planning Association (UNFPA). *Making Reproductive Rights and Sexual Health a Reality for All*. New York, NY: UNFPA; 2008

25. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. 2009;6(7):e1000097

26. Berenson AB, Rahman M. A randomized controlled study of two educational interventions on adherence with oral contraceptives and condoms. *Contraception*. 2012;86(6):716–724

27. Castaño PM, Bynum JY, Andrés R, Lara M, Westhoff C. Effect of daily text messages on oral contraceptive continuation: a randomized controlled trial. *Obstet Gynecol*. 2012;119(1):14–20

28. Hall KS, Westhoff CL, Castaño PM. The impact of an educational text message intervention on young urban women's knowledge of oral contraception. *Contraception*. 2013;87(4):449–454

29. Kirby D, Raine T, Thrush G, Yuen C, Sokoloff A, Potter SC. Impact of an intervention to improve contraceptive use through follow-up phone calls to female adolescent clinic patients. *Perspect Sex Reprod Health*. 2010;42(4):251–257

30. Vahdat HL, L'Engle KL, Plourde KF, Magaria L, Olawo A. There are some questions you may not ask in a clinic: providing contraception information to young people in Kenya using SMS. *Int J Gynaecol Obstet*. 2013;123(suppl 1):e2–e6

31. Katz KS, Rodan M, Milligan R, et al. Efficacy of a randomized cell phone–based counseling intervention in postponing subsequent pregnancy among teen mothers. *Matern Child Health J*. 2011;15(suppl 1):S42–S53

32. Gazmararian JA, Elon L, Yang B, Graham M, Parker R. Text4baby program: an opportunity to reach underserved pregnant and postpartum women? *Matern Child Health J*. 2014;18(1):223–232

33. Song H, May A, Vaidhyanathan V, Cramer EM, Owais RW, McRoy S. A two-way text-messaging system answering health questions for low-income

pregnant women. *Patient Educ Couns.* 2013;92(2):182–187

34. Kharbanda EO, Stockwell MS, Fox HW, Andres R, Lara M, Rickert VI. Text message reminders to promote human papillomavirus vaccination. *Vaccine.* 2011;29(14):2537–2541

35. Matheson EC, Derouin A, Gagliano M, Thompson JA, Blood-Siegfried J. Increasing HPV vaccination series completion rates via text message reminders. *J Pediatr Health Care.* 2014;28(4):e35–e39

36. Currie MJ, Schmidt M, Davis BK, et al. "Show me the money": financial incentives increase chlamydia screening rates among tertiary students: a pilot study. *Sex Health.* 2010;7(1):60–65

37. Dokkum NFB, Koekenbier RH, van den Broek IVF, et al. Keeping participants on board: increasing uptake by automated respondent reminders in an Internet-based chlamydia screening in the Netherlands. *BMC Public Health.* 2012;12:176

38. Bailey SM, Scalley BC, Gilles MT. Text 2 treat: using SMS to recall clients for treatment. *Int J STD AIDS.* 2014;25(14):1–3

39. Huppert JS, Reed JL, Munafo JK, et al. Improving notification of sexually transmitted infections: a quality improvement project and planned experiment. *Pediatrics.* 2012;130(2). Available at: www.pediatrics.org/cgi/content/full/130/2/e415

40. Giorgio MM, Kantor LM, Levine DS, Arons W. Using chat and text technologies to answer sexual and reproductive health questions: Planned Parenthood pilot study. *J Med Internet Res.* 2013;15(9):e203

41. Gold J, Lim MSC, Hellard ME, Hocking JS, Keogh L. What's in a message? Delivering sexual health promotion to young people in Australia via text messaging. *BMC Public Health.* 2010;10:792

42. Jones R, Hoover DR, Lacroix LJ. A randomized controlled trial of soap opera videos streamed to smartphones to reduce risk of sexually transmitted human immunodeficiency virus (HIV) in young urban African American women. *Nurs Outlook.* 2013;61(4):205–215.e3

43. Juzang I, Fortune T, Black S, Wright E, Bull S. A pilot programme using mobile phones for HIV prevention. *J Telemed Telecare.* 2011;17(3):150–153

44. Levine D, McCright J, Dobkin L, Woodruff AJ, Klausner JD. SEXINFO: a sexual health text messaging service for San Francisco youth. *Am J Public Health.* 2008;98(3):393–395

45. Lim MSC, Hocking JS, Aitken CK, et al. Impact of text and email messaging on the sexual health of young people: a randomised controlled trial. *J Epidemiol Community Health.* 2012;66(1):69–74

46. Nsakala GV, Coppieters Y, Kayembe PK. An innovative approach to using both cellphones and the radio to identify young people's sexual concerns in Kinshasa, Democratic Republic of Congo. *Arch Public Health.* 2014;72(1):21

47. Willoughby JF, Jackson K. "Can you get pregnant when u r in the pool?": young people's information seeking from a sexual health text line. *Sex Educ.* 2013;13(1):96–101

48. Belzer ME, Naar-King S, Olson J, et al; Adolescent Medicine Trials Network for HIV/AIDS Interventions. The use of cell phone support for non-adherent HIV-infected youth and young adults: an initial randomized and controlled intervention trial. *AIDS Behav.* 2014;18(4):686–696

49. Dowshen N, Kuhns LM, Gray C, Lee S, Garofalo R. Feasibility of interactive text message response (ITR) as a novel, real-time measure of adherence to antiretroviral therapy for HIV+ youth. *AIDS Behav.* 2013;17(6):2237–2243

50. Hailey JH, Arscott J. Using technology to effectively engage adolescents and young adults into care: STAR TRACK Adherence Program. *J Assoc Nurses AIDS Care.* 2013;24(6):582–586

51. Puccio JA, Belzer M, Olson J, et al. The use of cell phone reminder calls for assisting HIV-infected adolescents and young adults to adhere to highly active antiretroviral therapy: a pilot study. *AIDS Patient Care STDS.* 2006;20(6):438–444

52. Cornelius JB, Cato M, Lawrence JS, Boyer CB, Lightfoot M. Development and pretesting multimedia HIV-prevention text messages for mobile cell phone delivery. *J Assoc Nurses AIDS Care.* 2011;22(5):407–413

53. Cornelius JB, Dmochowski J, Boyer C, St Lawrence J, Lightfoot M, Moore M. Text-messaging-enhanced HIV intervention for African American adolescents: a feasibility study. *J Assoc Nurses AIDS Care.* 2013;24(3):256–267

54. Reed JL, Huppert JS, Taylor RG, et al. Improving sexually transmitted infection results notification via mobile phone technology. *J Adolesc Health.* 2014;55(5):690–697

55. Suffoletto B, Akers A, McGinnis KA, Calabria J, Wiesenfeld HC, Clark DB. A sex risk reduction text-message program for young adult females discharged from the emergency department. *J Adolesc Health.* 2013;53(3):387–393

56. Lim EJ, Haar J, Morgan J. Can text messaging results reduce time to treatment of *Chlamydia trachomatis? Sex Transm Infect.* 2008;84(7):563–564

57. Mangone ER, Agarwal S, L'Engle K, et al. Sustainable cost models for mHealth at scale: modeling program data from m4RH Tanzania. *PLoS One.* 2016;11(1):e0148011

58. Head KJ, Noar SM, Iannarino NT, Grant Harrington N. Efficacy of text messaging–based interventions for health promotion: a meta-analysis. *Soc Sci Med.* 2013;97:41–48

59. Al-Shorbaji N, Geissbuhler A. Establishing an evidence base for e-health: the proof is in the pudding. *Bull World Health Organ.* 2012;90(5):322–322A

60. Kumar S, Nilsen WJ, Abernethy A, et al. Mobile health technology evaluation: the mHealth evidence workshop. *Am J Prev Med.* 2013;45(2):228–236

61. Tomlinson M, Rotheram-Borus MJ, Swartz L, Tsai AC. Scaling up mHealth: where is the evidence? *PLoS Med.* 2013;10(2):e1001382

62. Lee SH, Nurmatov UB, Nwaru BI, Mukherjee M, Grant L, Pagliari C. Effectiveness of mHealth interventions for maternal, newborn and child health in low- and middle-income countries: systematic review and meta-analysis. *J Glob Health.* 2016;6(1):010401

63. Levine R, Corbacio A, Konopka S, et al. *African Strategies for Health. mHealth Compendium.* Arlington, VA: Management Sciences for Health; 2015

Mobile Phone Interventions for Adolescent Sexual and Reproductive Health: A Systematic Review

Kelly L. L'Engle, Emily R. Mangone, Angela M. Parcesepe, Smisha Agarwal and Nicole B. Ippoliti

Pediatrics 2016;138;

DOI: 10.1542/peds.2016-0884 originally published online August 23, 2016;

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/138/3/e20160884
References	This article cites 54 articles, 4 of which you can access for free at: http://pediatrics.aappublications.org/content/138/3/e20160884#BIBL
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): **Health Information Technology** http://www.aappublications.org/cgi/collection/health_information_technology_sub **Adolescent Health/Medicine** http://www.aappublications.org/cgi/collection/adolescent_health:medicine_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://www.aappublications.org/site/misc/reprints.xhtml

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

Mobile Phone Interventions for Adolescent Sexual and Reproductive Health: A Systematic Review

Kelly L. L'Engle, Emily R. Mangone, Angela M. Parcesepe, Smisha Agarwal and Nicole B. Ippoliti

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/138/3/e20160884

Data Supplement at:
http://pediatrics.aappublications.org/content/suppl/2016/08/22/peds.2016-0884.DCSupplemental

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™