

A systematic review of randomised controlled trials of the effects of digital health interventions on postpartum contraception use

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ABSTRACT (250 word limit)

Background

Digital health interventions(DHI) have been used to enhance the uptake of postpartum contraception and reduce unmet contraception needs. We conducted a systematic review of the effectiveness of DHI on postpartum contraceptive use and repeated pregnancy.

Method

We searched MEDLINE, EMBASE, Global Health, CINAHL and Cochrane CENTRAL (1/1990-7/2020). Randomised controlled trials(RCTs) of DHI promoting contraception among pregnant or postpartum women were included. Two researchers screened articles and extracted data. We assessed the risk of bias, certainty of evidence(CoE) and conducted meta-analyses following Cochrane guidance.

Results

Twelve trials with 5527 women were included. Interventions were delivered by video(4 trials), mobile phone counselling(3 trials), short message services(4 trials) and computer(1 trial). During pregnancy or the postpartum period, mobile phone counselling had an uncertain effect on the use of postpartum contraception(RR 1.37, 95% CI 0.82 to 2.29, very low CoE); video-based education may moderately improve contraception use(RR 1.48, 95%CI 1.01 to 2.17, low CoE); while SMS education probably modestly increased contraception use(RR 1.12, 95%CI 1.01 to 1.23, moderate CoE). Mobile phone counselling probably increased long-acting-reversible contraception(LARC) use(RR 4.23, 95%CI 3.01 to 5.93, moderate CoE). Both mobile phone counselling(RR 0.27, 95%CI 0.01 to 5.77, very low CoE) and videos(RR 1.25, 95%CI 0.24-6.53, very low CoE) had uncertain effects on repeated pregnancy.

Conclusions

During pregnancy or postpartum period, videos may moderately increase postpartum contraception use and SMS probably modestly increase postpartum contraception use. The effects of DHI on repeated pregnancy are uncertain. Further well-conducted RCTs of DHI would strengthen the evidence of effects on contraction use and pregnancy.

INTRODUCTION

Inter-pregnancy intervals of less than 12 months between childbirth and the subsequent conception are associated with adverse outcomes for women and their children including fetal growth restriction, preterm birth and neonatal mortality (1–3). Very short interpregnancy intervals of five months or less, convey the highest obstetric risks and are associated with higher maternal mortality, third trimester bleeding and premature rupture of membranes (4). Globally, 40% of unmet contraceptive needs are among women who have given birth within the past year (5) (6). Unmet need for modern contraception in the post-partum period is considerable, ranging from 25% to 96% of postpartum women in different low-income countries (3). In the UK, one in thirteen women presenting for abortion or childbirth had conceived within a year of previous childbirth (7). Low uptake of postpartum contraception can be attributed to a lack of knowledge about fertility following childbirth, misconceptions about contraceptives, fear of side effects, and difficulties accessing contraception following childbirth(9) For example, some believe lactation is effective for contraception(8), without knowing only exclusive breastfeeding is effective within six-month postpartum(9).

To deal with the problem of unmet need for postpartum contraception, antenatal counselling, pre-discharge counselling, postpartum home-based and community-based care and training may be helpful, but challenges remain in delivering these services to all women (10,11). Digital and blended (digital combined with face-to-face) approaches to providing contraceptive information and supplies could help overcome some geographic, social and knowledge-based barriers to postpartum contraceptive use (12)(15). Digital Health Intervention (DHI) have been proven successful in other health behaviours such as smoking cessation, appointment attendance (13) and postpartum weight management(17). Moreover, pregnant and postpartum women are increasingly relying on electronic healthcare resources such as mobile apps as sources of information for self-care(14). This provides a favourable environment to support the use of DHI for contraception in postpartum women(15)(18)

Previous reviews in the area of contraception have focussed on specific digital modes of delivery and the reviews are now out-of-date(15) such as mobile phone-based interventions(16), telephone support(15,17) mobile application software or SMS(18). The objective of this review was to synthesise evidence regarding the effectiveness of DHI on contraceptive use, including the use of long-acting reversible contraception (LARC) in the postpartum period, repeat pregnancy at 12 months and time to repeat pregnancy. We also synthesised evidence on secondary outcomes: satisfaction with DHI, attendance for postnatal visits, exclusive breastfeeding and safety of DHI.

METHODS

This systematic review was conducted according to Cochrane(19) and Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines(20)

We included RCTs published in English from 1990 to July 2020 among pregnant or postpartum women that examined DHI on postpartum contraceptive education. We defined the postpartum period from childbirth up to 12 months post-birth. Quasi-randomised and non-randomised controlled trials were excluded. Interventions targeted at postpartum contraception use and delivered solely by or with at least one digital health intervention (DHI) component were included. DHI included: mobile phone-based (phone calls, SMS); computer-based; web-based (websites, online platforms, e-mails), multimedia (videos, interactive animations), social media interventions (Facebook, blogging) etc. The comparator was either standard of care (SOC) or other non-digital intervention. The four primary outcomes were: use of contraception that is at least moderately effective, as defined by WHO (23); uptake of long-acting reversible contraception (LARC, including intra-uterine devices (IUD) / implants); repeat pregnancy at 12-month postpartum and time to repeat pregnancy. The five secondary outcomes included satisfaction with the intervention or contraceptive methods, knowledge and attitudes towards contraception, attendance rate of postnatal visits (any visits related to current childbirth or future childbearing,), prevalence of exclusive breastfeeding (EBF), safety of intervention and contraceptive methods.

We searched MEDLINE, EMBASE, Global Health, CINAHL and Cochrane Central Trial of Controlled Trials (CENTRAL) from January 1990 to July 2020 using the search strategy (supplementary material 1). YS searched ClinicalTrials.gov and WHO ICTRP for ongoing trials. Reference lists of 12 systematic reviews (15–17,22–30) were examined for additional citations.

After deduplication, all titles, abstracts and potentially relevant full-text journals were screened by two reviewers independently according to the eligibility criteria after pilot testing. Discrepancies were resolved by discussion and consulting a third reviewer. Data were extracted by YS and cross-checked by another reviewer. Intervention characteristics were described using the Template of Intervention Description and Replication (TIDieR)(31). Other information included background information, study design, aim; participants' characteristics and outcomes. YS and SR or LB independently assessed the risk of bias using the Cochrane Risk of Bias tool (32). After summarising studies according to the type of intervention, comparison and outcomes, we conducted meta-analyses if sufficient data were available for at least two studies employing the same DHI reporting the same outcomes. Statistical analysis was carried out using Cochrane Review Manager 5.4. For dichotomous outcomes, the Mantel-Haenszel risk ratio (RR) was calculated with a 95% confidence interval. For time-to-event analysis outcome, hazard ratio (HR) and standard error were retrieved.

Meta-analysis was performed separately on different modes of DHI: mobile phone counselling, video-based interventions and SMS. We used intention-to-treat data. Pooled estimates were calculated from the most homogeneous time point. Fixed-effect meta-analysis was carried out. When substantial heterogeneity ($I^2 > 50\%$ or $p < 0.1$) was observed, a random-effects meta-analysis was used. Cluster-randomised controlled trials were reduced to their effective sample size using the “design effect”. For studies with multiple intervention arms, we combined different treatment groups to create a single pair-wise comparison against the comparison group.

Statistical heterogeneity was assessed using the I^2 statistic and was considered significant if $I^2 > 50\%$ (19). Subgroup analyses were performed based on different durations of follow-up according to Cochrane Handbook: long-term effect (follow-up

≥1 year), medium-term (≥3 months and ≤ 1 year) and short-term (<3 months).
(Supplementary material 2)

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was used to assess the confidence of evidence(33).

RESULTS

The search generated 9,812 records after removing duplication. We assessed 102 full-text articles for eligibility and excluded 90 for the reasons stated in Figure 1. Twelve studies were included. One ongoing trial with published protocol has been identified(34).

Twelve studies met the inclusion criteria. (35–46). The studies were published between 2003 to 2020 with four studies in the US(35–37,41), three studies in Kenya(40,42,43), one each in Ecuador(38), Columbia(39), Spain(44), Egypt(45) and India(46). Ten studies were RCTs and two(44,46) were cluster-RCTs. There were a total of 5,527 participants. All participants were pregnant or postpartum. Two studies focused on adolescents (below 18 years)(36,37); one study on young women (below 25 y/o) (35); five studies on women aged above 14-15 y/o (38,39,42,43,46) and the remaining four on women aged above 18 y/o(40,41,44,45). There is one ongoing study (34).

All interventions were described in Table 1 and a more detailed version can be found in table S1 in the supplementary file. The result of meta-analysis was shown in Figure 2.

Figure 1. Study Flow Diagram

Table 1 Characteristics of studies

Study, Country, Design	Participants	Intervention	Comparator
Gilliam 2003, USA, RCT	43 African American females ≤ 25 y/o	Counselling, video-tape, written materials about oral contraceptives (OC) before hospital discharge 48 hours post-birth	SOC with OC counselling by resident-physician
Barnet 2009, USA, 3-arm RCT	237 female 12-18 y/o, ≥ 24 gestational weeks	Computer-assisted motivation interviewing (CAMI) as part of multicomponent (CAMI+) or single component (CAMI-only) home-based intervention for 24 months post-birth	Usual care
Carmichael 2019, India, cluster RCT	70 health sub-centres with 4 villages/subcentres randomly selected for surveys (cluster RCT); at follow-up total of 1553 randomly selected respondents (women who had given birth in past year)	Information Communication Technology-Continuum of Care Service (ICT-CSS) tool; multiple mobile-phone-based job aids and videos for 12 month post-birth	SOC
Katz 2011, USA, RCT	249 African American or Latina 15-19 y/o females	Mobile phone counselling (biweekly for 12 months)	General services in schools or healthcare facilities
Maslowsky 2016, Ecuador, RCT	178 mothers ≥ 15 y/o, spoke Spanish	Mobile phone counselling (one within 48 hours from hospital discharge; phone access to nurse for 1 months)	Brief discharge instructions delivered by a nurse
Hersh 2018, Columbia, RCT	240 women ≥ 20 gestational weeks	Video and subsequent dialogue with counsellor (once)	Face-to-face conversation with the same counselling protocol
McConnell 2018, Kenya, 6-arm RCT	686 women 18-40 y/o, gestation age ≥ 7 months	SMS text reminder (one SMS at 5-week post-birth)	Counselling on PFP 6-week post-birth
Staley 2018, USA, RCT	84 women ≥ 18 y/o, ≥ 28 gestational weeks with English fluency	Video (one video before routine prenatal visit)	Routine prenatal care
Unger 2018, Kenya, 3-arm RCT	300 pregnant women ≥ 14 y/o, < 36 gestational weeks with access to mobile phone	Mobile WACH SMS education (weekly SMS until 12-week post-birth)	Routine clinic-based care
Harrington 2019, Kenya, RCT	254 HIV-female ≥ 14 y/o, ≥ 28 gestational weeks English, Kiswahili or Dholuo competency with daily access to mobile phone	Mobile WACH SMS education (weekly SMS until 6-month post-birth)	Standard antenatal care
Reyes-Lacalle 2020, Spain, Cluster RCT	703 Women ≥ 18 y/o with mobile phone and internet access, not illiterate	SMS reminder (at 37 week of gestation) and blog information (since 35 week of gestation)	Counselling by midwives
Shaaban 2020, Egypt, RCT	1000 women with live birth at > 28 gestational weeks with mobile phone access	Mobile phone calls appointment reminders (one call 5-week post-birth; one 48-hour before appointment; two follow-up calls after appointment)	Counselling before discharge

*Follow-up time measured from birth; SOC, standard of care; y/o, years old

Figure 2 Forest plots of studies comparing interventions to controls for primary outcomes (a) Use of contraception (b) Use of LARC (c) Repeat pregnancy. Note: studies within forest plots are sorted by types of digital health intervention.

For the format of the interventions in the twelve RCTs, video-based interventions were used in four trials(35,39,41,46). Three of them were one-off interventions delivered in a healthcare facility setting, either during prenatal visits or the postpartum stay, with the video explaining the use of either oral contraceptives or long-acting reversible contraceptives (LARC)(35,39,41). The remaining video intervention was a part of the ICT tool which is led by community healthcare workers using special mobile phones in delivering healthcare informative videos, automate schedules of postnatal visits and other functions like tracking child immunizations(46). Three studies adopted mobile phone counselling which varied in the number of sessions(37,38,45). Two studies(42,43) employed the Mobile WACH SMS system to generate weekly tailored SMS for contraception education. SMS was also one of the intervention elements in two other studies(40,44) acting as a reminder for other non-DHI interventions and combined with the use of online blogs. Barnett 2009 used a computer-assisted motivational intervention (CAMI) which included answering a set of questions based on computer-assisted motivational intervention algorithm and subsequently receiving motivational interviewing about postpartum contraception matched to their motivation stage.

Only three trials specified a theoretical basis. Gilliam 2003 produced the video based on self-efficacy theory, Barnett(US) developed computer-assisted motivational intervention system based on the transtheoretical model and Harrington 2019 framed SMS based on the theory of planned behaviour.

For the aim of the interventions, three interventions primarily aimed at preventing or delaying repeated pregnancy(35–37); six targeted at increasing postpartum contraception(38–40,42–44) and two focused on LARC use(41,45). Carmichael 2019(46) adopted a multi-level intervention aiming at increasing contraception use and home visits about family planning or postpartum health among other things.

For outcomes, nine studies(35,38,40–46) reported contraception use; seven studies (38,40,42–46) further reported use of LARC; four studies(35–37,45) reported repeat pregnancy and two (36,37) included time to repeat pregnancy. Some studies reported on secondary outcomes. No studies reported data on the safety of interventions delivered by DHI. Risk of Bias regarding random sequence generation and allocation concealment was low in 83% and 67% of trials respectively, and unclear in the remaining trials. Risk of Bias for other domains varied (Supplementary material 3)

The CoE (certainty of evidence) ranged from very low to moderate for the four primary outcomes. (table 2)

Table 2: Summary of findings table

Outcome	Effect	Certainty [^]	Description	
No of participants (studies)	Relative (CI)	Absolute (CI)		
Use of contraception				
Mobile phone postpartum contraception counselling, N=1178 (2 RCTs) (38,45)	RR 1.37 (0.82 to 2.29)	16.6% more (8.1 fewer to 58 more)	⊕○○○ VERY LOW ^{a,b,c}	The effect of mobile phone postpartum contraception counselling on use of contraception is uncertain
Video intervention for contraception counselling, N=117 (2 RCTs) (35,41)	RR 1.48 (1.01 to 2.17)	19.4% more (0.4 more to 47.2 more)	⊕⊕○○ LOW ^{a,b}	Video intervention for contraception counselling may result in a moderate increase in use of contraception.
SMS contraceptive education, N=642 (3 RCTs) (40,42,43)	RR 1.12 (1.01 to 1.23)	6.7% more (0.6 more to 12.9 more)	⊕⊕⊕○ MODERATE ^a	SMS contraceptive education probably results in a modest increase in use of contraception.
SMS reminders and blogging N=204 (1 RCT) (44)	RR 1.03 (0.99 to 1.08)	2.9% more (1 fewer to 7.7 more)	⊕⊕○○ LOW ^{a,b}	SMS reminder and blogging may result in little to no difference in use of contraception.
Complex video intervention using ICT-CSS phones; N=1553 (1 RCT) (46)	RR 1.36 (0.84 to 2.21)	1.2% more (0.6 fewer to 4.2 more)	⊕⊕○○ LOW ^{a,b}	Complex video intervention using ICT-CSS phones may result in an increase in use of contraception
Use of LARC				
Mobile phone postpartum contraception counselling, N=1178 (2 RCTs) (38,45)	RR 4.23 (3.01 to 5.93)	20.7% more (12.9 more to 31.7 more)	⊕⊕⊕○ MODERATE ^{a,d}	Mobile phone postpartum contraception counselling probably results in a large increase in use of LARC.
Video intervention for contraception counselling, N=84 (1 RCT) (41)	RR 1.30 (0.64 to 2.63)	7.1% more (8.6 fewer to 38.8 more)	⊕⊕○○ LOW ^{a,c}	Video intervention for contraception counselling may result in a little or no difference in use of LARC.
SMS contraceptive education, N=642 (3 RCTs) (40,42,43)	RR 0.98 (0.71 to 1.35)	0.3% fewer (4.5 fewer to 5.5 more)	⊕⊕○○ LOW ^{a,b}	SMS contraceptive education may result in little to no difference in use of LARC.
SMS reminders and blogging, N=204 (1 RCT) (44)	RR 1.40 (0.75 to 2.62)	5.5% more (3.5 fewer to 22.5 more)	⊕⊕○○ LOW ^{a,b}	SMS reminder and blogging may result in a moderate increase in use of LARC.
Repeated pregnancy				
Mobile phone postpartum contraception counselling, N=1249 (2 RCTs) (37,45)	RR 0.27 (0.01 to 5.77)	6.4% fewer (8.7 fewer to 42 more)	⊕○○○ VERY LOW ^{e,f}	The effect of mobile phone postpartum contraception counselling on repeat pregnancy is uncertain

Video intervention for contraception counselling, N=33 (1 RCT) (35)	RR 1.25 (0.24 to 6.53)	3.3% more (10.1 fewer to 73.7 more)	⊕○○○ VERY LOW ^{a,d,e}	The effect of video intervention for contraception counselling on repeat pregnancy is uncertain.
Computer-based intervention (CAMI-) N=155 (1 RCT) (36)	RR 0.69 (0.37 to 1.28)	7.8% fewer (15.8 fewer to 7 more)	⊕○○○ VERY LOW ^{a,b,c}	The effect of computer-based intervention (CAMI-) on repeat pregnancy is uncertain
Time to repeat pregnancy				
Mobile phone postpartum contraception counselling, N=249 (1 RCT) (37)	HR 0.86 (0.55 to 1.32)	/	⊕⊕○○ LOW ^{g,h}	Mobile phone postpartum contraception counselling may result in a modest delay repeated pregnancy.
Computer-based intervention (CAMI-) N=155 (1 RCT) (36)	HR 0.67 (0.33 to 1.38)		⊕○○○ VERY LOW ^{a,b,c}	The effect of computer-based intervention (CAMI-) on time to repeat pregnancy is uncertain.

^For details on the grading of certainty, please see Table S2

CI: 95% Confidence interval; **RR:** Risk ratio

GRADE Working Group grades of evidence (47)

High certainty: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Primary outcomes

1. Use of contraception (nine trials)

Two studies (38,45) showed that mobile phone counselling (Ecuador and Egypt) had uncertain effect on the use of contraception (RR 1.37, 95% CI 0.82 to 2.29, very low CoE; n=1178; 3-6 months). Two studies(35,41) in the US showed that video-based intervention may moderately improve the use of contraception (RR 1.48, 95%CI 1.01 to 2.17, low CoE; n=117; 3-12 months). Carmichael 2019(46)with video intervention was not pooled as it was a complex multi-level intervention. It may moderately increase the use of modern method (RR 1.36, 95%CI 0.84 to 2.21; low CoE; n=1553). Three studies(40,42,43) in Kenya which adopted SMS education showed a probable modest increase in the use of postpartum contraception (RR 1.12, 95% CI 1.02 to 1.23, moderate CoE; n=642; 4-6 months). Reyes-Lacalle(44)(Spain) showed that online blogs and SMS reminders may have little or no effect on the use of contraception (RR 1.03, 95% CI 0.99 to 1.08, low CoE; n=204; 12-month). One study (46) showed that complex video intervention may result in an increase in the use of contraception (RR1.36, 95% CI 0.84 to 2.21, low CoE; n = 1553)

2. Use of LARC (seven trials)

Two studies (38,45) showed that mobile phone call counselling probably largely improve use of LARC (RR 4.23, 95% CI 3.01 to 5.93, moderate CoE; n=1178; 3-6 months). The effect of women receiving video intervention on the use of LARC compared to women with standard of care is uncertain (RR 1.30, 95%CI 0.64 to 2.63, low CoE; n=84)(41,44). Three studies(40,42,43) in Kenya showed that SMS education may have little or no effect on the use of LARC (RR 0.98, 95% CI 0.71 to 1.35, low CoE; n=642). The effect of receiving information through online blogs and SMS reminders on LARC is uncertain (RR 1.40, 95% CI 0.75 to 2.62; n=204, low CoE; 12-month).

3. Subsequent pregnancy within the study period (four trials)

It was uncertain whether mobile phone counselling reduces repeated pregnancy (two trials(37,45) in Ecuador and Egypt (RR 0.27, 95% CI 0.01 to 5.77, very low CoE; n=1249; 6-24 months). For video-based intervention conducted in US(35), the effect on subsequent pregnancy was also uncertain (RR1.25, 95%CI 0.24 to

6.53, very low CoE; n=33; 12-month). Barnett (US) showed that independent-computer-assisted motivational intervention had uncertain effect on repeat pregnancy (RR 0.69, 95%CI 0.37 to 1.28, very low CoE; n=155; 24-month).

4. Time to repeat pregnancy (two trials)

Barnett(36) showed computer-assisted motivational intervention had uncertain effect on the next pregnancy beyond 24 months (CAMI- HR 0.67, 95% CI 0.33 to 1.38; very low CoE). Katz(37) reported that mobile phone counselling may modestly delay next pregnancy (HR 0.86, 95%CI 0.55 to 1.32, low CoE; n=249; 24-month).

Secondary outcomes

1. Satisfaction with the intervention (three trials)

All three studies reported a relatively high level of satisfaction. Maslowsky (Ecuador)(38) only collected data for women receiving mobile phone calls but not women receiving standard of care using a 3-level scale. 98% of the participants would like to access the service at their next birth. Participants in Reyes-Lacalle (Spain) (44) also reported high-level of satisfaction (Intervention: 97.2%, Control: 88.7%).

Two studies in Kenya involving SMS interventions used a 5-level scale for participants' rating of satisfaction towards their contraceptive method choice in particular (42,43). SMS may lead to little or no difference in women's satisfaction with the choice of contraceptive method (RR 1.05, 95%CI 0.92 to 1.19; n=873; 6-12 months).

2. Knowledge and attitude towards contraception (two trials)

Gilliam (US) (35) reported women under combined video and counselling intervention had statistically significant improvement in knowledge and the difference was maintained throughout the study. No data were provided.

In Hersh (Columbia) (39), mean scores of knowledge assessments were similar between conversational and video groups. The mean overall scores increased

from approximately three to five out of seven. Women receiving video intervention may have little or no difference in knowledge attainment compared to women receiving conversation counselling (RR 0.97, 95%CI 0.92 to 1.03; n=239).

3. Attendance rate of postnatal visits (four trials)

Staley(US)(41) showed that a video intervention may modestly increase attendance of postpartum visits (RR 1.15, 95%CI 0.85 to 1.56; n=84).

Maslowsky(Ecuador)(38) showed that mobile phone calls may increase attendance of postnatal check-ups within 1-week of birth (1-week RR 1.26, 95%CI 0.91 to 1.73). Shaaban(Egypt)(45) showed that mobile phone calls probably substantially increase attendance of family planning clinics by 6-week postpartum (RR 1.72, 95%CI 1.52 to 1.95). Carmichael(46) showed that a video intervention may increase the rate of home visits after birth. (Week 1: RR 1.30, 95%CI 0.94 to 1.81; Week 2-4 RR 1.16, 95%CI 0.78 to 1.72)

4. Prevalence of exclusive breastfeeding (two trials)

Unger(Kenya)(42) showed that both 2-way and 1-way SMS interventions increased the probability of EBF at 10-week and 16-week postpartum significantly. By 24-week, SMS education probably increased the prevalence of exclusive breastfeeding (RR 1.34, 95%CI 1.02 to 1.76). This was of moderate certainty due to the unclear risk of bias. Carmichael (46) increased the probability of EBF within 6 months (RR 1.11, 95%CI 0.79 to 1.55).

5. Safety of DHI and contraceptive methods

No study reported any outcomes on safety information about DHI and contraceptive methods chosen by the participants.

Subgroup analyses were performed based on length of follow-up for two outcomes: use of contraception and use of LARC in the short-term, medium-term and long-term. (Forest plots included in supplementary material 2. There was no subgroup difference for either, use of contraception (p=0.98) or use of LARC (p=0.85). For use of contraception, DHI was associated with a significant increase in the intervention group for the medium-term outcome (RR 1.26, 95%CI 1.03, 1.55) but not in the

short-term or long-term outcome. For use of LARC, DHI may be associated with a modest increase in the intervention group in medium-term outcome (RR 1.78, 95%CI 0.97, 3.27) but not in short-term or long-term outcomes.

DISCUSSION

This review pooled data from 12 RCTs with a total of 5,527 participants to explore the effects of DHI on postpartum contraception use and pregnancy outcomes. Mobile phone counselling probably substantially increases the use of LARC, but has an uncertain effect on the use of any contraception and repeat pregnancy. Video interventions may moderately improve the use of any contraception and LARC compared to standard of care, but have uncertain effects on reducing subsequent pregnancy. SMS education may modestly increase use of any contraception but may make little or no difference in the use of LARC. For multicomponent interventions, SMS reminders together with internet blogs may moderately increase the use of LARC but may have little or no effect on use of contraception. Finally, the effect of computer-assisted motivational intervention on delaying the time to repeat pregnancy or reducing repeat births is uncertain. For secondary outcomes, DHI achieved a high level of satisfaction. Evidence regarding the effects of videos on knowledge was mixed. There was no evidence regarding the effects of mobile phone counselling or messages on knowledge. Videos and mobile phone counselling increased postnatal visits attendance rate and SMS increased exclusive breastfeeding. There was no evidence regarding the effects of SMS messages on postnatal visits or the effects of videos or mobile phone counselling on exclusive breastfeeding. No information was provided by the RCTs in this review regarding safety and harm of DHI, for instance, inadequacy of counselling of side effects of contraception and confidentiality in case of data leakage as a result of digital technology.

Strengths and limitations of this study

This review was the first to explore postpartum contraceptive outcomes through DHI. There are several strengths (53,54). We used recommended methods for conducting

our review including describing interventions based on TIDieR guidance and Grade assessment for the certainty of evidence assessment. We have made an *a priori* decision to report estimates for interventions delivered by each type of DHI separately.

The review included trials of DHI in different geographical locations including both high-income countries (HIC) and lower-middle-income countries (LMIC). For example, mobile phone (Ecuador, Egypt, USA), video (Columbia, USA) and SMS interventions (Kenya and Spain). This illustrates the feasibility of DHI in different settings despite the potential differences in technological infrastructure in HIC and LMIC.

Nevertheless, this study has some limitations. The overall quality of evidence on the effectiveness of DHI on postpartum contraception remained limited. Most of them provided insufficient information for the risk of bias assessments. Random sequence generation was considered satisfactory but allocation concealment was unclear in six studies. It was not feasible to blind participants, yet most outcomes were self-reported, potentially resulting in reporting bias (42,43). Only some primary outcomes had objective measures such as urine early pregnancy test(37) and birth certificates for repeat births (40). Most outcomes in the meta-analysis were derived from two to three studies. Several outcomes were downgraded due to imprecision.

We were unable to assess publication bias as funnel plots were inconclusive as at least 10 studies are required normally for the individual outcome. We did not assess outcome reporting bias by comparing protocols to the published papers. There were high levels of heterogeneity in the pooled analyses of mobile phone counselling, making it inappropriate to pool the results.

Studies were limited in number and quality. It was difficult to assess the applicability to other settings. Completeness of the results may be hindered by the lack of reporting on safety outcomes and cost-effectiveness.

In relation to other studies

Our systematic review adds to the current knowledge related to DHI for postpartum contraception use. Previous reviews focused on specific digital media or general pregnancy-related health education (14,17) such as childbirth, maternal mood problems, smoking cessation etc or contraception in general populations of women (16).

Our findings regarding the effects of DHI for contraception use and clinic attendance postpartum are similar to the effects of DHI in general or other populations of women(16).

In this review, SMS (42)and mobile-phone-based intervention (46) may enhance exclusive breastfeeding in women whereas telephone interventions have shown an inconsistent effect on exclusive breastfeeding (17). Our results are consistent with previous studies in showing high satisfaction with DHI (48). DHI have demonstrated impacts on contraceptive knowledge and attitudes in populations of young women (3,35).

Meaning of the study: possible mechanisms

DHI in this review aimed to synthesise the evidence on the effectiveness DHI in promoting postpartum contraception and repeated pregnancy. We were not able to elucidate the mechanism of action as only three trials specified a theoretical basis or theory of change, and reporting on intermediate outcomes such as knowledge or attitudes was sparse.

Implication for future research and practice

The covid -19 pandemic resulted in large shifts to remote care. There was increased use of digital media, especially mobile phone counselling and use of text messages, for delivering information and support for contraception. Our review shows that DHI were better or no worse when compared to standard care, but DHI in this review were not evaluated in a context where face-to-face care was restricted (such as during the covid-19 pandemic). This review showed there are potential benefits of adopting DHI in addition to standard care as shown by one study where DHI was part of a complex intervention. Further RCTs are required to reliably establish the effects of interventions delivered solely or partly via DHI on postpartum contraception

use and pregnancy within 12 months of childbirth. Future work should also explore the mechanism of action of interventions.

KEY POINTS

When delivered in addition to standard care:

1. Video interventions may moderately improve the use of any contraception and LARC but have an uncertain effect on reducing subsequent pregnancy
2. SMS education may moderately increase use of any contraception and LARC
3. Mobile phone counselling probably increases use of LARC, has uncertain effect on use of any contraception and reduced repeat pregnancy

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Authors Contributions

YS and CF conceived the idea for the project. YS designed the study with input from CF. YS, SB, SR and LB screened abstracts and papers for inclusion. YS, SB, SR and LB extracted data. YS and SB analysed the data. YS, SR and LB carried out the grade assessments with input from CF. All authors contributed to interpreting the data, critical review of drafts, have approved the final version and accept accountability for all aspects of the work.

Other information

This review was not registered, and no protocol was prepared.

REFERENCES

1. Conde-Agudelo A. Maternal morbidity and mortality associated with interpregnancy interval: cross sectional study. *BMJ* [Internet]. 2000 Nov 18;321(7271):1255–9. Available from: <https://www.bmj.com/lookup/doi/10.1136/bmj.321.7271.1255>
2. Fuentes-Afflick E. Interpregnancy interval and the risk of premature infants. *Obstetrics & Gynecology* [Internet]. 2000 Mar;95(3):383–90. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0029784499005839>
3. Smith GCS. Interpregnancy interval and risk of preterm birth and neonatal death: retrospective cohort study. *BMJ* [Internet]. 2003 Aug 9;327(7410):313–0. Available from: <https://www.bmj.com/lookup/doi/10.1136/bmj.327.7410.313>
4. Conde-Agudelo A. Maternal morbidity and mortality associated with interpregnancy interval: cross sectional study. *BMJ* [Internet]. 2000 Nov 18;321(7271):1255–9. Available from: <https://www.bmj.com/lookup/doi/10.1136/bmj.321.7271.1255>
5. Ali MM CJ and SI. Causes and Consequences of Contraceptive Discontinuation: Evidence from 60 Demographic and Health Surveys [Internet]. Geneva; 2012. Available from: https://apps.who.int/iris/bitstream/handle/10665/75429/9789241504058_eng.pdf
6. WHO. Programming Strategies for Postpartum Family Planning. Programming Strategies for Postpartum Family Planning. 2013.

7. Heller R, Cameron S, Briggs R, Forson N, Glasier A. Postpartum contraception: a missed opportunity to prevent unintended pregnancy and short inter-pregnancy intervals. *Journal of Family Planning and Reproductive Health Care* [Internet]. 2016 Apr;42(2):93–8. Available from: <http://jfprhc.bmj.com/lookup/doi/10.1136/jfprhc-2014-101165>
8. Elweshahi HMT, Gewaifel GI, Sadek SSED, El-Sharkawy OG. Unmet need for postpartum family planning in Alexandria, Egypt. *Alexandria Journal of Medicine* [Internet]. 2018 Jun 1;54(2):143–7. Available from: <https://www.tandfonline.com/doi/full/10.1016/j.ajme.2017.03.003>
9. Planned parenthood. Breastfeeding as Birth Control [Internet]. 2020 [cited 2020 Jun 30]. Available from: <https://www.plannedparenthood.org/learn/birth-control/breastfeeding>
10. Kontos E, Blake KD, Chou WYS, Prestin A. Predictors of eHealth Usage: Insights on The Digital Divide From the Health Information National Trends Survey 2012. *J Med Internet Res* [Internet]. 2014 Jul 16;16(7):e172. Available from: <http://www.jmir.org/2014/7/e172/>
11. Escoffery C. Gender Similarities and Differences for e-Health Behaviors Among U.S. Adults. *Telemedicine and e-Health* [Internet]. 2018 May;24(5):335–43. Available from: <https://www.liebertpub.com/doi/10.1089/tmj.2017.0136>
12. Bacchus LJ, Reiss K, Church K, Colombini M, Pearson E, Naved R, et al. Using Digital Technology for Sexual and Reproductive Health: Are Programs Adequately Considering Risk? *Glob Health Sci Pract* [Internet]. 2019 Dec 23;7(4):507–14. Available from: <http://www.ghspjournal.org/lookup/doi/10.9745/GHSP-D-19-00239>
13. Buckingham SA, Williams AJ, Morrissey K, Price L, Harrison J. Mobile health interventions to promote physical activity and reduce sedentary behaviour in the workplace: A systematic review. *Digit Health* [Internet]. 2019 Jan 27;5:205520761983988. Available from: <http://journals.sagepub.com/doi/10.1177/2055207619839883>
14. Lee Y, Moon M. Utilization and Content Evaluation of Mobile Applications for Pregnancy, Birth, and Child Care. *Healthc Inform Res* [Internet]. 2016;22(2):73. Available from: <http://e-hir.org/journal/view.php?id=10.4258/hir.2016.22.2.73>
15. Lopez LM, Grey TW, Hiller JE, Chen M. Education for contraceptive use by women after childbirth. *Cochrane Database of Systematic Reviews* [Internet]. 2015 Jul 29; Available from: <https://onlinelibrary.wiley.com/doi/10.1002/14651858.CD001863.pub4>
16. Smith C, Gold J, Ngo TD, Sumpter C, Free C. Mobile phone-based interventions for improving contraception use. *Cochrane Database of Systematic Reviews* [Internet]. 2015 Jun 26; Available from: <https://onlinelibrary.wiley.com/doi/10.1002/14651858.CD011159.pub2>
17. Lavender T, Richens Y, Milan SJ, Smyth RM, Dowswell T. Telephone support for women during pregnancy and the first six weeks postpartum. *Cochrane Database of Systematic Reviews* [Internet]. 2013 Jul 18; Available from: <https://onlinelibrary.wiley.com/doi/10.1002/14651858.CD009338.pub2>
18. Bearak J, Popinchalk A, Alkema L, Sedgh G. Global, regional, and subregional trends in unintended pregnancy and its outcomes from 1990 to 2014: estimates from a Bayesian hierarchical model. *Lancet Glob Health* [Internet]. 2018 Apr;6(4):e380–9. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2214109X18300299>
19. Cochrane Database of Systematic Reviews. *Cochrane Handbook for Systematic Reviews of Interventions* [Internet]. Cochrane Database of Systematic Reviews. 2020. Available from: <https://training.cochrane.org/handbook>

20. Moher D. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Ann Intern Med* [Internet]. 2009 Aug 18;151(4):264. Available from: <http://annals.org/article.aspx?doi=10.7326/0003-4819-151-4-200908180-00135>
21. WHO. Family Planning - A global handbook for providers. 2018.
22. Chan KL, Chen M. Effects of Social Media and Mobile Health Apps on Pregnancy Care: Meta-Analysis. *JMIR Mhealth Uhealth* [Internet]. 2019;7(1):e11836. Available from: <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med1&NEWS=N&AN=30698533>
23. K.M. G, L.L. Z, E.A. D, A. AT, T.W. B, G. R, et al. Telehealth Interventions Designed for Women: an Evidence Map. *J Gen Intern Med* [Internet]. 2018;33(12):2191–200. Available from: <http://www.springerlink.com/content/120414/>
24. S.F.V. S, J.L. B, M. AC, A. B, A.S. M, M. V, et al. Assessing the Effect of mHealth Interventions in Improving Maternal and Neonatal Care in Low- and Middle-Income Countries: A Systematic Review. *PLoS One* [Internet]. 2016;11(5):e0154664. Available from: <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med13&NEWS=N&AN=27144393>
25. Wang K, Brown K, Shen SY, Tucker J. Social network-based interventions to promote condom use: a systematic review. *AIDS Behav* [Internet]. 2011;15(7):1298–308. Available from: <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med8&NEWS=N&AN=21811843>
26. K.C. H, N.A. A. Mobile health (mhealth) intervention for family planning program: An evidence from systematic review. *Indian J Public Health Res Dev* [Internet]. 2019;10(11):2414–9. Available from: <http://www.indianjournals.com/ijor.aspx?target=ijor:ijphrd&type=home>
27. F. R, S.M. DSG, C. DC, C. B, C. TC. State of knowledge on smartphone applications concerning contraception: A systematic review. *J Gynecol Obstet Hum Reprod* [Internet]. 2019;48(2):83–9. Available from: <https://www.journals.elsevier.com/journal-of-gynecology-obstetrics-and-human-reproduction>
28. Cameron S. Postabortal and postpartum contraception. *Best Pract Res Clin Obstet Gynaecol* [Internet]. 2014 Aug;28(6):871–80. Available from: <http://search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,shib&db=rzh&AN=107798824&site=ehost-live>
29. Abdel-Aleem H, El-Gibaly OMH, EL-Gazzar A, Al-Attar GST. Mobile clinics for women's and children's health. *Cochrane Database of Systematic Reviews* [Internet]. 2016;(8). Available from: <http://dx.doi.org/10.1002/14651858.CD009677.pub2>
30. Burgess CK, Henning PA, Norman W v, Manze MG, Jone HE, Jones HE, et al. A systematic review of the effect of reproductive intention screening in primary care settings on reproductive health outcomes. *Fam Pract* [Internet]. 2018 Apr;35(2):122–31. Available from: <http://fampra.oxfordjournals.org/>
31. Template for Intervention Description and Replication (TIDieR) [Internet]. [cited 2020 Jul 8]. Available from: <https://training.cochrane.org/resource/template-intervention-description-and-replication-tidier>
32. Higgins JPT, Altman DG, Gotzsche PC, Juni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ* [Internet]. 2011 Oct 18;343(oct18 2):d5928–d5928. Available from: <https://www.bmj.com/lookup/doi/10.1136/bmj.d5928>

33. Cochrane Database of Systematic Reviews. How the GRADE the quality of the evidence [Internet]. [cited 2020 Jul 18]. Available from: https://colorectal.cochrane.org/sites/colorectal.cochrane.org/files/public/uploads/how_to_grade.pdf
34. Gul X, Hameed W, Hussain S, Sheikh I, Siddiqui J ur R. A study protocol for an mHealth, multi-centre randomized control trial to promote use of postpartum contraception amongst rural women in Punjab, Pakistan. *BMC Pregnancy Childbirth* [Internet]. 2019 Dec 8;19(1):283. Available from: <https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-019-2427-z>
35. Gilliam M, Knight S, McCarthy M. Success with oral contraceptives: A pilot study. *Contraception*. 2004;69(5):413–8.
36. B. B, J. L, M. D, A.K. D, M.A. G, Barnet B, et al. Motivational intervention to reduce rapid subsequent births to adolescent mothers: A community-based randomized trial. *Ann Fam Med* [Internet]. 2009 Sep;7(5):436–45. Available from: <http://search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,shib&db=rzh&AN=105430843&site=ehost-live>
37. Katz K, Rodan M, Milligan R, Tan S, Courtney L, Gantz M, et al. Efficacy of a Randomized Cell Phone-Based Counseling Intervention in Postponing Subsequent Pregnancy Among Teen Mothers. *Matern Child Health J* [Internet]. 2011 Dec 2;15(S1):42–53. Available from: <http://search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,shib&db=rzh&AN=104605506&site=ehost-live>
38. Maslowsky J, Frost S, Hendrick CE, Trujillo Cruz FO, Merajver SD. Effects of postpartum mobile phone-based education on maternal and infant health in Ecuador. *International Journal of Gynecology & Obstetrics* [Internet]. 2016 Jul;134(1):93–8. Available from: <http://search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,shib&db=rzh&AN=116246518&site=ehost-live>
39. Hersh AR, Muñoz LF, Rincón M, Alvarez C, Tolosa JE, Moreno DJ, et al. Video compared to conversational contraceptive counseling during labor and maternity hospitalization in Colombia: A randomized trial. *Contraception*. 2018;98(3):210–4.
40. McConnell M, Rothschild CW, Ettenger A, Muigai F, Cohen J. Free contraception and behavioural nudges in the postpartum period: evidence from a randomised control trial in Nairobi, Kenya. *BMJ Glob Health* [Internet]. 2018;3(5):e000888. Available from: <https://gh.bmj.com/content/3/5/e000888>
41. Staley SA, Charm SS, Slough LB, Zerden ML, Morse JE. Prenatal Contraceptive Counseling by Video. *South Med J*. 2019;112(1):8–13.
42. Unger JA, Ronen K, Perrier T, DeRenzi B, Slyker J, Drake AL, et al. Short message service communication improves exclusive breastfeeding and early postpartum contraception in a low- to middle-income country setting: a randomised trial. *BJOG* [Internet]. 2018 Nov;125(12):1620–9. Available from: [http://obgyn.onlinelibrary.wiley.com/hub/journal/10.1111/\(ISSN\)1471-0528/](http://obgyn.onlinelibrary.wiley.com/hub/journal/10.1111/(ISSN)1471-0528/)
43. Harrington EK, Drake AL, Matemo D, Ronen K, Osoti AO, John-Stewart G, et al. An mHealth SMS intervention on Postpartum Contraceptive Use Among Women and Couples in Kenya: A Randomized Controlled Trial. *Am J Public Health* [Internet]. 2019 Jun;109(6):934–41. Available from: <http://search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,shib&db=rzh&AN=136340651&site=ehost-live>

44. Reyes-Lacalle A, Montero-Pons L, Manresa-Domínguez JM, Cabedo-Ferreiro R, Seguranyes G, Falguera-Puig G. Perinatal contraceptive counselling: Effectiveness of a reinforcement intervention on top of standard clinical practice. *Midwifery* [Internet]. 2020 Apr;83:N.PAG-N.PAG. Available from: <http://search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,shib&db=rzh&AN=142025723&site=ehost-live>
45. Shaaban OM, Saber T, Youness E, Farouk M, Abbas AM. Effect of a mobile phone-assisted postpartum family planning service on the use of long-acting reversible contraception: a randomised controlled trial. *European Journal of Contraception and Reproductive Health Care*. 2020;25(4):264–8.
46. Carmichael SL, Mehta K, Srikantiah S, Mahapatra T, Chaudhuri I, Balakrishnan R, et al. Use of mobile technology by frontline health workers to promote reproductive, maternal, newborn and child health and nutrition: A cluster randomized controlled trial in Bihar, India. *J Glob Health*. 2019;9(2).
47. GRADEpro [Internet]. 2020 [cited 2020 Jul 14]. Available from: <https://gradepro.org>
48. Palmer MJ, Henschke N, Villanueva G, Maayan N, Bergman H, Glenton C, et al. Targeted client communication via mobile devices for improving sexual and reproductive health. *Cochrane Database of Systematic Reviews* [Internet]. 2020 Jul 14;2020(8). Available from: <https://doi.wiley.com/10.1002/14651858.CD013680>

